THE CITY OF WINNIPEG

REQUEST FOR PROPOSAL

RFP NO. 112-2021

PROFESSIONAL CONSULTING SERVICES FOR COOLING UPGRADES - WATER PUMPING STATIONS

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PART B - BIDDING PROCEDURES

B1. CONTRACT TITLE

B1.1 PROFESSIONAL CONSULTING SERVICES FOR COOLING UPGRADES - WATER PUMPING STATIONS

B2. SUBMISSION DEADLINE

B2.1 The Submission Deadline is 12:00 noon Winnipeg time, April 29, 2021.

B2.2 The Project Manager or the Manager of Materials may extend the Submission Deadline by issuing an addendum at any time prior to the time and date specified in B2.1.

B3. SITE INVESTIGATION

B3.1 The Project Manager or an authorized representative will conduct a Site investigation tour of the Sites at the following dates, times and locations:

(a) April 7, 2021 at 9:00 a.m. at the McPhillips Regional Pumping Station (RPS), 360 McPhillips Street, Winnipeg, Manitoba;

(b) April 7, 2021 at 1:30 p.m. at the Hurst RPS, 60 Hurst Way, Winnipeg, Manitoba;

(c) April 9, 2021 at 9:00 a.m. at the MacLean RPS, 875 Lagimodière Boulevard, Winnipeg, Manitoba; and

(d) April 9, 2021 at 1:30 p.m. at the Deacon Booster Pumping Station (DBPS), PR 207, LOT 57082, Dugald, Manitoba.

B3.1.1 Proponents are required to register for the Site investigations by contacting the Project Manager no later than 4:00 p.m. on April 1, 2021.

B3.1.2 Proponents registered for a Site investigation must provide the City of Winnipeg's (City's) Project Manager with a Global Sanctions & Politically Exposed Persons Check obtained not earlier than one (1) year prior to the Site investigation.

(a) The Global Sanctions & Politically Exposed Persons Check may be obtained from Sterling Talent Solutions. Proponents will need to setup a Sterling Talent Solutions account prior to requesting individual background checks. This process should be done a minimum of 72 hours prior to requesting the first check. The account can be setup using the following link:

http://forms.sterlingbackcheck.com/partners/platform2-en.php?&partner=winnipegcity

Note that the check will take up to 48 hours to complete. Refer to E1.1 of PART E - Security Clearance for further information.

The Global Sanctions & Politically Exposed Persons Check may be obtained from Sterling Talent Solutions. Proponents will need to setup a Sterling Talent Solutions account prior to requesting individual background checks.

(b) The results of the Global Sanctions & Politically Exposed Persons Check must be received by the City directly through Sterling Talent Solutions. Proponents must set up an account with Sterling Talent Solutions directly under their company name and grant Sterling Talent Solutions permission to share the results of the Global Sanctions & Politically Exposed Persons Checks with the City.

B3.1.3 Attendees are required to wear grade 1 safety shoes (CSA Green Triangle), hard hats, hi-vis vests, and safety glasses for the Site investigations.

B3.1.4 Transportation to the Sites will be the responsibility of the Proponent.

B3.1.5 Depending on the number of Proponents anticipated to take part in the Site investigations and the COVID-19 requirements at the time of the Site investigations, second Site investigation dates may be proposed.

B3.2 Proponents are not permitted to take photographs or videos at the Site investigations. The Proponent may request pictures of specific areas or equipment from the Project Manager. Subject to the City's approval, the requested photographs will be shared with the Proponents.

B3.3 Further to D24, it is acknowledged that COVID-19 may impact how the Site investigations are conducted. A number of protocols have been implemented for the safety of all participants.

B3.3.1 The Site investigation will be carried out in accordance with the most stringent applicable Federal, Provincial, local government, and City of Winnipeg (City) guidelines and regulations for COVID-19 in place at the time of the Site investigation.

B3.3.2 The Proponent's representative will be required to complete the self-assessment in Appendix K or on the Manitoba Shared Health website https://sharedhealthmb.ca/covid19/screening-tool/ the day prior to and the day of the Site investigation. If the self-assessment recommends an additional COVID-19 assessment or self-isolation, the Proponent will be required to assign a different representative for the Site investigation with the appropriate clearances indicated in B3.1.2.

B3.4 Notwithstanding B3.1 and B3.3, the City may cancel or reschedule the Site investigations due to health and safety concerns stemming from COVID-19 or to adhere to current COVID-19 regulations.

B3.4.1 In the event that the Site investigations are unable to be held due to COVID-19, the City will consider providing virtual tours. This may include photographs and/or videos. Proponents will be provided the opportunity to request specific photographs and videos, subject to approval by the City.

B3.5 Although attendance at the Site Investigations is not mandatory, the City strongly suggests that Proponents attend.

B3.6 The Proponent shall not be entitled to rely on any information or interpretation received at the site investigation unless that information or interpretation is the Proponent's direct observation, or is provided by the Project Manager in writing.

B4. ENQUIRIES

B4.1 All enquiries shall be directed to the Project Manager indicated in D2.

B4.2 If the Proponent finds errors, discrepancies, or omissions in the Request for Proposal (RFP), or is unsure of the meaning or intent of any provision therein, the Proponent shall promptly notify the Project Manager of the error, discrepancy, or omission at least five (5) Business Days prior to the Submission Deadline.

B4.3 Responses to enquiries which, in the sole judgment of the Project Manager, require a correction to or a clarification of the RFP will be provided by the Project Manager to all Proponents by issuing an addendum.

B4.4 Responses to enquiries which, in the sole judgment of the Project Manager, do not require a correction to or a clarification of the RFP will be provided by the Project Manager only to the Proponent who made the enquiry.

B4.5 All correspondence or contact by Proponents with the City in respect of this RFP must be directly and only with the Project Manager. Failure to restrict correspondence and contact to the Project Manager may result in the rejection of the Proponents Proposal Submission.

B4.6 The Proponent shall not be entitled to rely on any response or interpretation received pursuant to B4 unless that response or interpretation is provided by the Project Manager in writing.

B4.7 Any enquiries concerning submitting through MERX should be addressed to:
MERX Customer Support
Phone: 1-800-964-6379
Email: merx@merx.com

B5. CONFIDENTIALITY

B5.1 Information provided to a Proponent by the City or acquired by a Proponent by way of further enquiries or through investigation is confidential. Such information shall not be used or disclosed in any way without the prior written authorization of the Project Manager. The use and disclosure of the Confidential Information shall not apply to information which:

(a) was known to the Proponent before receipt hereof; or

(b) becomes publicly known other than through the Proponent; or

(c) is disclosed pursuant to the requirements of a governmental authority or judicial order.

B5.2 The Proponent shall not make any statement of fact or opinion regarding any aspect of the RFP to the media or any member of the public without the prior written authorization of the Project Manager.

B6. ADDENDA

B6.1 The Project Manager may, at any time prior to the Submission Deadline, issue addenda correcting errors, discrepancies, or omissions in the RFP, or clarifying the meaning or intent of any provision therein.

B6.2 The Project Manager will issue each addendum at least two (2) Business Days prior to the Submission Deadline, or provide at least two (2) Business Days by extending the Submission Deadline.

B6.3 Addenda will be available on the MERX website at www.merx.com.

B6.4 The Proponent is responsible for ensuring that he/she has received all addenda and is advised to check the MERX website for addenda regularly and shortly before the Submission Deadline, as may be amended by addendum.

B6.5 The Proponent shall acknowledge receipt of each addendum in Paragraph 10 of Form A: Bid/Proposal. Failure to acknowledge receipt of an addendum may render a Proposal non-responsive.

B6.6 Notwithstanding B4, enquiries related to an Addendum may be directed to the Project Manager indicated in D2.

B7. PROPOSAL SUBMISSION

B7.1 The Proposal shall consist of the following components:

(a) **Section A** - Form A: Bid/Proposal in accordance with B8;

(b) **Section B** - Fees in accordance with B9.

B7.2 The Proposal should also consist of the following components:

(a) **Section C** - Experience of Proponent and Subconsultants in accordance with B10;

(b) **Section D** - Experience of Key Personnel Assigned to the Project, in accordance with B11;

(c) **Section E** - Project Understanding and Methodology in accordance with B12; and

(d) **Section F** - Project Schedule in accordance with B13.

B7.3 Further to B7.1 all components of the Proposal shall be fully completed or provided in the order indicated, and submitted by the Proponent no later than the Submission Deadline, with all required entries made clearly and completely, to constitute a responsive Proposal.

B7.4 Further to B7.2, all components of the Proposal should be fully completed or provided in the order indicated, and submitted by the Proponent no later than the Submission Deadline, with all required entries made clearly and completely.

B7.5 Proposal format, including number of pages, size of pages and, font, etc., will not be regulated, except that the Proposal should contain a table of contents, have page numbering, and be in the Sections identified above. Proponents are encouraged to use their creativity to submit a Proposal which provides the requested information for evaluation and other information which illustrates the strength of their proposed solution.

B7.6 The Proposal shall be submitted electronically through MERX.

B7.6.1 Proposals will **only** be accepted electronically through MERX.

B7.7 Proponents are advised that inclusion of terms and conditions inconsistent with the RFP, will be evaluated in accordance with B22.1(a).

B7.8 Any cost or expense incurred by the Proponent that is associated with the preparation of the Proposal shall be borne solely by the Proponent.

B8. PROPOSAL (SECTION A)

B8.1 The Proponent shall complete Form A: Bid/Proposal, making all required entries.

B8.2 Paragraph 2 of Form A: Bid/Proposal shall be completed in accordance with the following requirements:

(a) if the Proponent is a sole proprietor carrying on business in his/her own name, his/her name shall be inserted;

(b) if the Proponent is a partnership, the full name of the partnership shall be inserted;

(c) if the Proponent is a corporation, the full name of the corporation shall be inserted;

(d) if the Proponent is carrying on business under a name other than his/her own, the business name and the name of every partner or corporation who is the owner of such business name shall be inserted.

B8.2.1 If a Proposal is submitted jointly by two or more persons, each and all such persons shall identify themselves in accordance with B8.2.

B8.3 In Paragraph 3 of Form A: Bid/Proposal, the Proponent shall identify a contact person who is authorized to represent the Proponent for purposes of the Proposal.

B8.4 Paragraph 13 of Form A: Bid/Proposal shall be signed in accordance with the following requirements:

(a) if the Proponent is a sole proprietor carrying on business in his/her own name, it shall be signed by the Proponent;

(b) if the Proponent is a partnership, it shall be signed by the partner or partners who have authority to sign for the partnership;

(c) if the Proponent is a corporation, it shall be signed by its duly authorized officer or officers;

(d) if the Proponent is carrying on business under a name other than his/her own, it shall be signed by the registered owner of the business name, or by the registered owner's authorized officials if the owner is a partnership or a corporation.

B8.4.1 The name and official capacity of all individuals signing Form A: Bid/Proposal should be entered below such signatures.

B8.5 If a Proposal is submitted jointly by two or more persons, the word "Proponent" shall mean each and all such persons, and the undertakings, covenants and obligations of such joint Proponents in the Proposal and the Contract, when awarded, shall be both joint and several.

B9. FEES (SECTION B)

B9.1 The Proponent shall complete Form B: Fees.

B9.2 The Proposal shall include a Fixed Fee for the following sections identified in D7 Scope of Services:

(a) Project Management in accordance with D8;

(b) Historical Information Review and Stakeholder Engagement in accordance with D9;

(c) Geotechnical Engineering Services in accordance with D10;

(d) Preliminary Design in accordance with D11;

(e) Detailed Design and Tender in accordance with in D12;

(f) Contract Administration - Non-Resident Services in accordance with D13;

(g) Commissioning Services in accordance with D15;

(h) As-Built Drawings in accordance with D16;

(i) The Fixed Fee for As-Built Drawings shall be twenty thousand dollars ($20,000.00), to be paid upon satisfactory completion of the Record Drawings as described in D16; and

(i) Project Closeout in accordance with D17.

B9.3 The Proposal shall include a Time Based Fee schedule for the following sections identified in D7 Scope of Services:

(a) Resident Services in accordance with D14;

(i) Time-Based Fees shall be based on on-site inspection services as described in D14.

(ii) For Proposal purposes these fees shall be based on 900 hours of inspection.

(iii) The number of hours listed in B9.3(a)(ii) is to be considered approximate only. The City will use this number for the purpose of comparing bids.

(iv) The number of hours for which payment will be made to the Proponent for resident services is to be determined by the actual number of hours worked by the Proponent.

(b) Additional Work Allowance in accordance with D18.

(i) The Proponent shall include an additional work allowance of $70,000.00 in their Proposal.

(ii) The additional work allowance is to be used for engineering and design services that arise due to unforeseen conditions that may occur during the project.

(iii) The additional work allowance is to be included in the calculation of total Fees proposed by the Proponent.

(iv) The additional work allowance shall only be used with written permission of the Project Manager and formally documented in a Change in Scope of Services form.

B9.4 There will be no fee escalation allowed for yearly adjustments, promotion, etc. The fee scale shall be fixed for the duration of the Project.

B9.5 Adjustments to Fees will only be considered based on increases to the Scope of Services.

B9.5.1 If the City requires additional services, the rates to be used will be based on the rates provided in the Proponent's Proposal.

B9.5.2 The City will not consider an adjustment to the Fees based on changes in the Project budget or the Final Total Construction Cost.

B9.6 Notwithstanding C1.1(b), Fees shall include costs for out of town travel, related meals and accommodations for the duration of the Project and shall not be considered an Allowable Disbursement.

B9.7 The Fee Proposal shall also include an allowance for Allowable Disbursements as defined in C1.1(b), but shall exclude the costs of any materials testing, soils and hazardous materials investigation during construction.

B9.8 Notwithstanding C11.1, Fees submitted shall not include the Goods and Services Tax (GST) or Manitoba Retail Sales Tax (MRST, also known as PST), which shall be extra where applicable.

B9.9 Payments to Non-Resident Consultants are subject to Non-Resident Withholding Tax pursuant to the Income Tax Act (Canada).

B9.9.1 Fees stated shall not include any costs which may be incurred by the Consultant with respect to any applicable funding agreement obligations as outlined in D26. Any such costs shall be determined in accordance with D26.

B10. EXPERIENCE OF PROPONENT AND SUBCONSULTANTS (SECTION C)

B10.1 Proposals should include:

(a) details demonstrating the history and experience of the Proponent and Subconsultants in providing programming; design, management of the project, contract administration services, and commissioning services on two projects only of similar complexity, scope, and value.

(i) If more than two projects are submitted, only the first two referenced projects will be evaluated.

B10.2 For each project listed in B10.1(a), the Proponent should submit:

(a) description of the project;

(b) role of the consultant;

(c) project's original contracted consulting cost and final consulting cost

(i) where the original contracted consulting cost and final cost differ by over 15 percent, the Proponent should submit an explanation;

(d) design schedule (anticipated Project schedule and actual Project delivery schedule),

(i) where the anticipated project design schedule and the actual project design delivery schedule differ, the Proponent should submit an explanation;

(e) project owner; and

(f) reference information (two current names with telephone numbers and email addresses per project).

(i) References should have worked directly on the projects described, such as project manager or owner's representative.

(ii) References may be used to confirm the information provided in the proposal.

(iii) Other sources not named in the references may be contacted to verify information provided.

B10.2.1 Where applicable, information should be separated into Proponent and Subconsultant project listings.

B10.3 The Proposal should include general firm profile information, including years in business, average volume of work, number of employees, and other pertinent information for the Proponent and all Subconsultants.

B11. EXPERIENCE OF KEY PERSONNEL ASSIGNED TO THE PROJECT (SECTION D)

B11.1 Describe your approach to overall team formation and coordination of team members.

B11.1.1 Include an organizational chart for the Project.

(a) Identify by name all personnel with over 5% of the total project hours.

(b) Clearly identify Subconsultants to be engaged by the Proponent on the organizational chart.

B11.2 Identify the following Key Personnel assigned to the Project:

(a) the Proponent's project manager;

(b) the lead electrical and/or instrumentation and control professional;

(c) the lead process and/or mechanical professional;

(d) the resident contract administrator; and

(e) non-resident contract administrator.

B11.2.1 Include the following for each of the Key Personnel:

(a) educational background and degrees;

(b) professional recognition;

(c) job title;

(d) years of experience in current position; and

(e) years of experience in design and construction.

B11.2.2 Roles of each of the Key Personnel in the Project should be identified in the organizational chart referred to in B11.1.1.

B11.2.3 For each Key Personnel identified, list at **two comparable** projects in which they have played a primary role similar to that proposed for this Project. If a project selected for a Key Personnel is included in B10, provide only the project name and the role of the Key Personnel. For other projects provide the following:

(a) description of project;

(b) role of the person;

(c) project owner; and

(d) reference information (two current names with telephone numbers and email addresses per project).

(i) references should have worked directly on the projects described, such as the Project Manager or Contract Administrator.

(ii) references may be utilized to verify the information provided in the Proposal.

B11.2.4 If a Key Personnel is assigned to multiple roles (as identified in the organizational chart referred to in B11.1.1), two (2) comparable projects as detailed in B11.2.3 are required for each role of the Key Personnel.

B12. PROJECT UNDERSTANDING AND METHODOLOGY (SECTION E)

B12.1 Describe your firm's project management approach and team organization during the performance of Services, so that the evaluation committee has a clear understanding of the methods the Consultant will use in the delivery of this Project. The methods shall include:

(a) activities to be performed either by the Proponent's employees or by Subconsultants at an office located outside of the Province of Manitoba. Identify proposed arrangements (i.e. conference calls, webinars, travel, communication protocol, etc.) involving out-of-town employees to participate in coordination and review functions; and

(b) the collaborative process/method to be used by the Key Personnel of the team in the various phases of the Project.

B12.2 Proposals shall include:

(a) the methodology that the Proponent intends to use to carry out the Scope of Services;

(i) the methodology should be presented in accordance with the Scope of Services identified in D7 – Scope of Services.

(b) the Proponent's team's understanding of the broad functional and technical requirements;

(c) the work activities related to the Scope of Services;

(d) the Deliverables associated with the Scope of Services;

(e) all significant assumptions and interpretations related to the Scope of Services; and

(f) any other insight, proposed usage of innovation, or identification of risks related to the Scope of Services that demonstrates the Proponent's suitability to the Project.

B12.3 The Proposal should include Form P: Person Hours for all disciplines and or phases identified in D7 - Scope of Services.

B12.3.1 The total Fees on Form P: Person Hours should match Fees submitted in response to B9.

B12.3.2 For each Key Personnel identified in B11.2, list the percent of the person's time to be dedicated to the Project in accordance with the Scope of Services identified in D7.

B12.3.3 Consultants may use Form P: Person Hours or a table of their own design provided it includes all information requested in accordance with B12.3.

B12.3.4 A sample of Form P: Person Hours can be found at https://winnipeg.ca/matmgt/templates/information.stm

B13. PROJECT SCHEDULE (SECTION F)

B13.1 Proponents should present a carefully considered critical path method (CPM) schedule using Microsoft Project or similar project management software, complete with resource assignments (engineering disciplines), durations (weekly timescale) and milestone dates or events. The schedule should address each requirement of the Scope of Services identified in D7.

B13.2 Provide narrative that will describe how slippage in the proposed schedule will be managed and how the schedule will be re-evaluated to determine the impacts to the critical paths.

B13.3 Further to B13.1, the Proponent's schedule should reflect:

(a) the critical stages listed in D25. The Proponent shall give justification in the event that the milestone dates listed in the schedule deviate;

(b) the hours and resources indicated on Form P: Person Hours;

(c) City review requirements;

(d) Project meetings frequencies; and

(e) submission dates for required Deliverables.

B14. DISCLOSURE

B14.1 Various Persons provided information or services with respect to this RFP. In the City's opinion, this relationship or association does not create a conflict of interest because of this full disclosure. Where applicable, additional material available as a result of contact with these Persons is listed below.

B14.2 The Persons are:

(a) N/A

B15. CONFLICT OF INTEREST AND GOOD FAITH

B15.1 Proponents, by responding to this RFP, declare that no Conflict of Interest currently exists, or is reasonably expected to exist in the future.

B15.2 Conflict of Interest means any situation or circumstance where a Proponent or Key Personnel proposed for the Services has:

(a) other commitments;

(b) relationships;

(c) financial interests; or

(d) involvement in ongoing litigation;

that could or would be seen to:

(i) exercise an improper influence over the objective, unbiased and impartial exercise of the independent judgment of the City with respect to the evaluation of Proposals or award of the Contract; or

(ii) compromise, impair, or be incompatible with the effective performance of a Proponent's obligations under the Contract;

(e) has contractual or other obligations to the City that could or would be seen to have been compromised or impaired as a result of its participation in the RFP process or the Project; or

(f) has knowledge of confidential information (other than confidential information disclosed by the City in the normal course of the RFP process) of strategic and/or material relevance to the RFP process or to the Project that is not available to other Proponents and that could or would be seen to give that Proponent an unfair competitive advantage.

B15.3 In connection with its Proposal, each entity identified in B15.2 shall:

(a) avoid any perceived, potential, or actual Conflict of Interest in relation to the procurement process and the Project;

(b) upon discovering any perceived, potential, or actual Conflict of Interest at any time during the RFP process, promptly disclose a detailed description of the Conflict of Interest to the City in a written statement to the Project Manager; and

(c) provide the City with the proposed means to avoid or mitigate, to the greatest extent practicable, any perceived, potential, or actual Conflict of Interest and shall submit any additional information to the City that the City considers necessary to properly assess the perceived, potential, or actual Conflict of Interest.

B15.4 Without limiting B15.3, the City may, in its sole discretion, waive any and all perceived, potential, or actual Conflicts of Interest. The City's waiver may be based upon such terms and conditions as the City, in its sole discretion, requires to satisfy itself that the Conflict of Interest has been appropriately avoided or mitigated, including requiring the Proponent to put into place such policies, procedures, measures, and other safeguards as may be required by and be acceptable to the City, in its sole discretion, to avoid or mitigate the impact of such Conflict of Interest.

B15.5 Without limiting B15.3, and in addition to all contractual or other rights or rights at law or in equity or legislation that may be available to the City, the City may, in its sole discretion:

(a) disqualify a Proponent that fails to disclose a perceived, potential, or actual Conflict of Interest of the Proponent or any of its Key Personnel;

(b) require the removal or replacement of any Key Personnel proposed for the Services that has a perceived, actual, or potential Conflict of Interest that the City, in its sole discretion, determines cannot be avoided or mitigated;

(c) disqualify a Proponent or Key Personnel proposed for the Services that fails to comply with any requirements prescribed by the City pursuant to B15.4 to avoid or mitigate a Conflict of Interest; and

(d) disqualify a Proponent if the Proponent, or one of its Key Personnel proposed for the Project, has a perceived, potential, or actual Conflict of Interest that, in the City's sole discretion, cannot be avoided or mitigated, or otherwise resolved.

B15.6 The final determination of whether a perceived, potential or actual Conflict of Interest exists shall be made by the City, in its sole discretion.

B16. QUALIFICATION

B16.1 The Proponent shall:

(a) undertake to be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Proponent does not carry on business in Manitoba, in the jurisdiction where the Proponent does carry on business; and

(b) be financially capable of carrying out the terms of the Contract;

(c) have all the necessary experience, capital, organization, and equipment to perform the Services in strict accordance with the terms and provisions of the Contract;

(d) have or establish and staff an office in Winnipeg for the duration of the Project.

B16.2 The Proponent and any proposed Subconsultant (for the portion of the Services proposed to be subcontracted to them) shall:

(a) be responsible and not be suspended, debarred or in default of any obligations to the City. A list of suspended or debarred individuals and companies is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at https://winnipeg.ca/finance/findata/matmgt/listing/debar.pdf

B16.3 The Proponent and/or any proposed Subconsultant (for the portion of the Services proposed to be subcontracted to them) shall:

(a) have successfully carried out services for the programming; design, management of construction and contract administration for architectural and/or engineering projects of similar complexity, scope and value; and to those required for this Project; and

(b) be fully capable of performing the Services required to be in strict accordance with the terms and provisions of the Contract; and

(c) have a written workplace safety and health program, if required, pursuant to The Workplace Safety and Health Act (Manitoba);

(d) have the knowledge and resources to administer the requirements of The Workplace Safety and Health Act (Manitoba) during the construction works associated with this Contract; and

(e) undertake to meet all licensing and regulatory requirements of the appropriate governing authorities and associations in the Province of Manitoba.

(f) provide the Security Clearances as identified in PART E - Security Clearances.

B16.4 The Proponent shall submit, within three (3) Business Days of a request by the Project Manager, further proof satisfactory to the Project Manager of the qualifications of the Proponent and of any proposed Subconsultant.

B16.5 The Proponent shall provide, on the request of the Project Manager, full access to any of the Proponent's equipment and facilities to confirm, to the Project Manager's satisfaction, that the Proponent's equipment and facilities are adequate to perform the Services.

B17. OPENING OF PROPOSALS AND RELEASE OF INFORMATION

B17.1 Proposals will not be opened publicly.

B17.2 After award of Contract, the Contract amount and the name of the successful Proponent and their address will be available on the MERX website at www.merx.com.

B17.3 The Proponent is advised any information contained in any Proposal Submission may be released if required by The Freedom of Information and Protection of Privacy Act (Manitoba), by

other authorities having jurisdiction, or by law or by City policy or procedures (which may include access by members of City Council).

B17.3.1 To the extent permitted, the City shall treat as confidential information, those aspects of a Proposal Submission identified by the Proponent as such in accordance with and by reference to Part 2, Section 17 or Section 18 or Section 26 of The Freedom of Information and Protection of Privacy Act (Manitoba), as amended.

B17.4 Following the award of Contract, a Proponent will be provided with information related to the evaluation of his/her submission upon written request to the Project Manager.

B18. IRREVOCABLE OFFER

B18.1 The Proposal(s) submitted by the Proponent shall be irrevocable for the time period specified in Paragraph 11 of Form A: Bid/Proposal.

B18.2 The acceptance by the City of any Proposal shall not release the Proposals of the other responsive Proponents and these Proponents shall be bound by their offers on such Services for the time period specified in Paragraph 11 of Form A: Bid/Proposal.

B19. WITHDRAWAL OF OFFERS

B19.1 A Proponent may withdraw his/her Proposal without penalty prior to the Submission Deadline.

B20. INTERVIEWS

B20.1 The Project Manager may, in his/her sole discretion, interview Proponents during the evaluation process.

B21. NEGOTIATIONS

B21.1 The City reserves the right to negotiate details of the Contract with any Proponent. Proponents are advised to present their best offer, not a starting point for negotiations in their Proposal Submission.

B21.2 The City may negotiate with the Proponents submitting, in the City's opinion, the most advantageous Proposals. The City may enter into negotiations with one or more Proponents without being obligated to offer the same opportunity to any other Proponents. Negotiations may be concurrent and will involve each Proponent individually. The City shall incur no liability to any Proponent as a result of such negotiations.

B21.3 If, in the course of negotiations pursuant to B21.2, the Proponent amends or modifies a Proposal after the Submission Deadline, the City may consider the amended Proposal as an alternative to the Proposal already submitted without releasing the Proponent from the Proposal as originally submitted.

B22. EVALUATION OF PROPOSALS

B22.1 Award of the Contract shall be based on the following evaluation criteria:

(a)	compliance by the Proponent with the requirements of the RFP or acceptable deviation therefrom:	(pass/fail)
(b)	qualifications of the Proponent and the Subconsultants, if any, pursuant to B16:	(pass/fail)
(c)	Fees; (Section B)	40%
(d)	Experience of Proponent and Subconsultant; (Section C)	10%
(e)	Experience of Key Personnel Assigned to the Project; (Section D)	25%
(f)	Project Understanding and Methodology (Section E)	20%

(g) Project Schedule. (Section F) 5%

B22.2 Further to B22.1(a), the Award Authority may reject a Proposal as being non-responsive if the Proposal Submission is incomplete, obscure, or conditional, or contains additions, deletions, alterations, or other irregularities. The Award Authority may reject all or any part of any Proposal, or waive technical requirements or minor informalities or irregularities if the interests of the City so require.

B22.3 Further to B22.1(b), the Award Authority shall reject any Proposal submitted by a Proponent who does not demonstrate, in its Proposal or in other information required to be submitted, that it is qualified.

B22.4 If, in the sole opinion of the City, a Proposal does not achieve a pass rating for B22.1(a) and B22.1(b), the Proposal will be determined to be non-responsive and will not be further evaluated.

B22.5 Further to B22.1(c), Fees will be evaluated based on Fees submitted in accordance with B9.

B22.6 Further to B22.1(d), Experience of Proponent and Subconsultants (Section C) will be evaluated considering the information provided in response to B10, including but not limited to the following criteria:

(a) similarity of the Proponent's past referenced projects to this Project; and

(b) performance of the Proponent on past referenced projects included in the RFP and any City projects including to but not limited to:

(i) adherence to project budget;

(ii) adherence to project schedule; and

(iii) overall satisfaction with the Proponent.

B22.7 Further to B22.1(e), Experience of Key Personnel Assigned to the Project (Section D) will be evaluated considering the experience and qualifications of the Consultants and Subconsultant personnel on projects of comparable size and complexity, considering the information provided in B11, including but not limited to the following criteria:

(a) availability of Key Personnel;

(b) appropriateness of related years of experience of the Key Personnel;

(c) relevancy of experience of the Key Personnel;

(d) appropriateness of approach to overall team formation and coordination of team members.

B22.7.1 Proposals that receive less than half the available evaluation points for Experience of Key Personnel Assigned to the Project (Section D) will be rejected in accordance with B22.3.

B22.8 Further to B22.1(f), Project Understanding and Methodology (Section E) will be evaluated considering the information provided in response to B12 , including but not limited to the following criteria:

(a) appropriateness of the project management approach;

(b) consistency and completeness of the methodology;

(c) appropriateness of hours and personnel assigned to individual tasks;

(d) Proponent's understanding of the Project, including the deliverables, risks, and constraints; and

(e) demonstration of insight beyond the information presented in this RFP.

B22.8.1 Proposals that receive less than half the available evaluation points for Project Understanding and Methodology (Section E) will be rejected in accordance with B22.3.

B22.9 Further to B22.1(g), Project Schedule (Section F) will be evaluated considering the information provided in response to B13, including but not limited to the following criteria:

(a) completeness of the Project schedule;

(b) appropriateness of the timelines provided;

(c) logic and sequencing of the tasks, and

(d) appropriateness of the methodology to deal with slippage.

B22.10 Notwithstanding B22.1(d) to B22.1(g), where Proponents fail to provide a response to B7.2(a) to B7.2(d), the score of zero may be assigned to the incomplete part of the response.

B22.11 Proposals will be evaluated considering the information in the Proposal Submission and any interviews held in accordance with B20.

B22.12 Where references are requested, the reference checks to confirm information provided may not be restricted to only those submitted by the Proponent, and may include organizations representing Persons, known to have done business with the Proponent.

B23. AWARD OF CONTRACT

B23.1 The City will give notice of the award of the Contract, or will give notice that no award will be made.

B23.2 The City will have no obligation to award a Contract to a Proponent, even though one or all of the Proponents are determined to be qualified, and the Proposals are determined to be responsive.

B23.2.1 Without limiting the generality of B23.2, the City will have no obligation to award a Contract where:

(a) the prices exceed the available City funds for the Services;

(b) the prices are materially in excess of the prices received for similar services in the past;

(c) the prices are materially in excess of the City's cost to perform the Services, or a significant portion thereof, with its own forces;

(d) only one Proposal is received; or

(e) in the judgment of the Award Authority, the interests of the City would best be served by not awarding a Contract.

B23.3 Where an award of Contract is made by the City, the award shall be made to the qualified Proponent submitting the most advantageous offer.

B23.4 The City may, at its discretion, award the Contract in phases.

B23.5 Further to B23.4 the City reserves the right to negotiate and award future phases to the successful Proponent.

B23.6 Further to Paragraph 7 of Form A: Bid/Proposal and C4, the City may issue an award letter to the successful Proponent in lieu of execution of Contract Documents

B23.6.1 The Contract documents as defined in C1.1(o)(ii) in their entirety shall be deemed to be incorporated in and to form a part of the award letter notwithstanding that they are not necessarily attached to or accompany said award letter.

B23.7 The form of Contract with the City of Winnipeg will be based on the Contract as defined in C1.1(o).

B23.8 If funding for the Services is provided to the City of Winnipeg by the Government of Manitoba and/or the Government of Canada, Proponents are advised that the terms of D26 shall immediately take effect upon confirmation of such funding, regardless of when funding is confirmed.

B23.9 Following the award of Contract, a Proponent will be provided with information related to the evaluation of its Proposal upon written request to the Project Manager.

B23.10 If, after the award of Contract, the Project is cancelled, the City reserves the right to terminate the Contract. The Proponent will be paid for all Services rendered up to time of termination.

PART C - GENERAL CONDITIONS

C0. GENERAL CONDITIONS

C0.1 The *General Conditions for Consultant Services* (Revision 2017-03-24) are applicable to the Services of the Contract.

C0.1.1 The *General Conditions for Consultant Services* are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/gen_cond.stm.

C0.2 A reference in the RFP to a section, clause or subclause with the prefix "**C**" designates a section, clause or subclause in the *General Conditions for Consultant Services*.

PART D - SUPPLEMENTAL CONDITIONS

GENERAL

D1. GENERAL CONDITIONS

D1.1 In addition to the *General Conditions for Consultant Services*, these Supplemental Conditions are applicable to the Services of the Contract.

D2. PROJECT MANAGER

D2.1 The Project Manager is:

Jeff Brooks, C.E.T.

Telephone No. 204 986-2521

Email Address: jeffbrooks@winnipeg.ca

D2.2 At the pre-commencement meeting, the Project Manager will identify additional personnel representing the Project Manager and their respective roles and responsibilities for the Services.

D3. BACKGROUND

D3.1 The City's Regional Water Distribution System (RDS) consists of three RPS (MacLean RPS, McPhillips RPS, and Hurst RPS) and two booster pumping stations (DBPS and Taché Booster Pumping Station). The MacLean, McPhillips, and Hurst RPSs as well as the DBPS require cooling upgrades. The booster pumping stations and the RPS are Critical Infrastructure for the City. The failure of any of the pumping systems at these facilities has the potential to disrupt the City's residential, commercial, industrial, and fire protection water supplies.

D3.2 The DBPS station pumps the treated water from the Winnipeg Drinking Water Treatment Plant to the three RPSs' reservoirs. The pumping arrangement inside the DBPS consists of three 900 horsepower two speed booster pumps and two smaller 450 horsepower booster pumps (P-D001A and P-D002A) which have magnetic drive couplings.

D3.2.1 The 450 horsepower booster pumps (P-D001A and P-D002A) pumps are intended as the normal or primary pumps for the DBSP when the station's intermediate and discharge header valves are all open, a condition noted as being the common header configuration. This arrangement allows treated water flows between 200 to 350 MLD, which the 450 horsepower booster pumps should be able to meet the majority of the daily demands.

D3.2.2 The magnetic drive coupling on a 450 horsepower booster pump varies the flowrate of the pump while maintaining a constant speed at the electric motor. Adjusting the gap of the magnets in the coupling changes the amount of rotational slippage of the coupling. This rotational slippage alters the speed of the pump and flowrate of the pump. The increased rotational slippage also generates heat within the coupling. If the coupling was to overheat, the magnets would degauss rendering the pumps inoperable.

D3.2.3 To remove the heat generated by the rotational slippage, a glycol solution is sprayed on the magnets in the coupling. The glycol solution flows by gravity to a buffer tank which is open to atmosphere. The hot glycol solution is pumped from the buffer tank to an air-cooled fluid cooler located outside the DBPS. The absorbed heat in the glycol solution is rejected to the fluid cooler and the cooled glycol solution flows back to the magnetic drive coupling.

D3.2.4 Currently the 450 horsepower booster pumps are shutdown when the outside air temperature exceeds 28 degrees Celsius to prevent the couplings from overheating.

D3.2.5 P-D001A and P-D002A operating data from September 1, 2019 to August 31, 2020 is included in Appendix B – DBPS P-D001A and P-D002A Operational Data.

D3.3 The MacLean RPS and the McPhillips RPS each provide approximately thirty percent of the City's daily water demand within the RDS.

D3.3.1 The MacLean RPS has five distribution pumps with two driven by natural gas engines and three driven by electric motors. This station typically operates continuously.

D3.3.2 The McPhillips RPS has six distribution pumps with three driven by natural gas engines and three driven by electric motors. This station typically is shutdown during lower demand periods at night.

D3.3.3 During daily peak water demand periods at least one of the five natural gas engine pumps is in operation.

D3.3.4 The heat generated within the operating natural gas engine is rejected to potable water using multiple water-cooled heat exchangers. The used potable water is then discharged to the sanitary sewer.

D3.4 The Hurst RPS provides approximately forty percent of the City's daily water demand within the RDS.

D3.4.1 Under normal conditions, the station operates continuously and suitable space temperatures need to be maintained while operating at Firm Capacity.

D3.4.2 To prevent the Hurst RPS from overheating under Firm Capacity, the station utilises a chiller water distribution system consisting of:

(a) a 140-ton R-22 water cooled chiller;

(b) a cooling tower;

(c) a condenser water pumping loop;

(d) a chilled water pumping loop; and

(e) two air handling units with water cooling coils located on the roof of the facility.

D3.4.3 The Hurst RPS chiller water distribution system was installed in the mid 1990's and has reached the end of its service life.

D3.4.4 The chiller water distribution system at the Hurst RPS must be operational from the first day of May through to fourth week of October. During the remainder of the year, the Hurst RPS operates in a free cooling mode.

D4. DEFINITIONS

D4.1 When used in this RFP:

(a) "**Additional Work Allowance**" means a cash allowance that is to be used for engineering and project management in the event pre-existing unforeseen Site conditions or City instigated changes that arise during the various stages of the Project.

(b) "**AHJ**" means Authority Having Jurisdiction which is an organization, office or individual responsible for enforcing the requirements of a code, standard or by-law, or for approving equipment, materials, and installation or a procedure;

(c) "**ANSI**" means American National Standards Institute;

(d) "**As-Built Drawings**" means drawings prepared by a third party, or by the professional using information furnished by the contractor or other field staff;

(e) "**ASHRAE**" means American Society of Heating, Refrigeration and Air-conditioning Engineers;

(f) "**ASME**" means American Society of Mechanical Engineers ;

(g) "**AWWA**" means American Water Works Association;

(h) "**CAD**" means AutoCAD drawings;

(i) "**Class 1 Estimate**" means an estimate used to check tenders. The maturity level of the final overall design deliverables shall range from 65 percent to 100 percent. The typical costing methodology shall be detailed unit costs with detailed take-off items. The expected low to high variation in the accuracy range based on the complexity and remoteness of this Work shall be minus 10 percent to plus 15 percent with an 80 percent confidence interval;

(j) "**Class 3 Estimate**" means an estimate used to for budget authorization. The maturity level of the final overall design deliverables shall range from 10 percent to 40 percent. The typical costing methodology shall be semi-detailed unit costs with assembly level line items. The expected low to high variation in the accuracy range based on the complexity and remoteness of this Work shall be minus 20 percent to plus 30 percent with an 80 percent confidence interval;

(k) "**Class 5 Estimate**" means an estimate used to for concept screening assessment of different systems. The maturity level of the final overall design deliverables shall range from up to two percent. The typical costing methodology shall be factored for capacity, parametric models, analogy or judgement. The expected low to high variation in the accuracy range based on the complexity and remoteness of this Work shall be minus 50 percent to plus 100 percent with an 80 percent confidence interval;

(l) "**Commissioning**" means the process of verifying that equipment, Unit-Processes, systems, subsystems, and facility areas are installed, tested and capable of being operated and maintained to perform in conformance with the Drawings and specifications. Commissioning includes, but is not limited to, satisfactory delivery, installation, training, testing, demonstration, performance verification, and document delivery for all equipment and unit processes required under the work;

(m) "**Competent Person**" means a worker, who in relation to specific work:

(i) is qualified because of education, knowledge, training, and experience to perform the work; and

(ii) is familiar with the codes, standards, by-laws, regulations, and other legislation that are applicable to the work;

(n) "**Construction Documents**" means the Drawings, specifications, schedules and supporting documents issued for construction which are revised to any and all revisions from the tender period including requests for equals that form part of the construction contract.

(o) "**Consultant Progress Report**" as described in D8.3.

(p) **"CPM"** means critical path method used to determine the longest stretch of dependent activities and measuring the time required to complete activities from start to finish;

(q) "**Critical Infrastructure**" means components system that cannot typically be taken out of service for extended periods to facilitate construction and inadvertent damage caused to the component would likely have catastrophic consequences;

(r) "**CSA**" means Canadian Standards Association;

(s) "**CWO**" means a change work order

(t) **"DBM"** means Design Basis Memorandum a document prepared by the Consultant during the design phase, to establish the basic design parameters for the project.

(u) "**DBPS**" means the Deacon Booster Pumping Station;

(v) **"Firm Capacity"** means the RPS's pumping capacity when the largest pump in the RPS is out of service;

(w) "**Historical Drawings**" means technical drawings and sketches of the existing facilities, systems and/or processes that have not been confirmed for accuracy and relevancy to the current installed conditions on Site;

(x) "**HVAC**" means the heating, ventilation, and air-conditioning systems of a building;

(y) "**ILD**" means Instrument Loop Diagram: An engineering drawing which symbolically represents a single control loop identifying control components and interconnections.

Special situations may necessitate a combination of loops on one drawing. A loop diagram may document electrical or pneumatic instruments or a combination of both;

(z) "**I/O**" means an input or output from an instrumentation device or panel, which is either an analog signal, a digital signal, or an interlock;

(aa) "**Key Personnel"** means an individual designated in a Proponent's Proposal Submission to perform a lead role in one or more of the proposed key organizational positions indicated in this RFP for the Proponent or its team members;

(bb) "**MCC**" means a Motor Control Centre;

(cc) "**MLD**" means a flow rate of a fluid measured in millions of litres per day;

(dd) "**NPS**" means nominal pipe size which is generally associated with the inside diameter for sizes up to 12 inches. For sizes 14 inches and beyond, the NPS is equal to the outside diameter in inches;

(ee) "**PDF**" means a Portable Document Format electronic file;

(ff) "**% Work Complete**" means the percent maturity level of a particular task and/or deliverable for the Project. This is not a reflection of the actual effort/cost expended in relation to the budgeted effort/cost;

(gg) "**P&ID**" means process and instrumentation diagram which is a detailed diagram in that shows the piping and process equipment together with the instrumentation and control devices;

(hh) "**PLC**" means programmable logic controller;

(ii) "**PLC Panel**" means a rated electrical/instrumentation enclosure that houses PLCs, cable management systems, UPS power sources, relays, field terminations, etc. used in the control of processes;

(jj) "**RDS**" mean Regional Water Distribution System

(kk) "**RPS**" mean Regional Pumping Station;

(ll) **"SCADA"** means Supervisory Control and Data Acquisition which is a control system architecture that uses computers, networked data communications, and graphical user interfaces for high-level process supervisory management, but uses other peripheral devices such as programmable logic controllers and discrete controllers to interface to the process plant or machinery;

(mm) **"Scope of Service"** means all Services executed under this Contract;

(nn) **"Three-Point Estimate**" means a weighted average of the optimistic, likely, and pessimistic time lines or costs for a task and shown as the anticipated task's time or cost using the following formula:

$$\boldsymbol{Anticipated} = \frac{Optimistic + 4\ x\ Likely + Pessimistic}{6}$$

(oo) "**WBS**" means work breakdown structure or a deliverable oriented hierarchical decomposition of the work packages to be executed by the Project team. The work package expresses the work, duration and costs for the tasks required to produce the sub-deliverable; and

(pp) "**W&W**" means the City of Winnipeg Water and Waste Department.

D5. RELEVENT DOCUMENTS AND HISTORICAL DRAWINGS

D5.1 Relevant documents and drawings are available by request to the Project Manager after completion of a Non-Disclosure Agreement. These documents and drawings will be released at the sole discretion of the City. A list of the available documents is included in Appendix C – Relevant Documents and Appendix D – Historical Drawings. The Non-Disclosure Agreement can be found in Appendix E – Non-Disclosure Agreement.

D6. GENERAL REQUIREMENTS

D6.1 Consultant

D6.1.1 The Consultant shall ensure that the Scope of Services is performed under direct supervision of a Professional Engineer.

(a) All drawings, reports, recommendations, and other documents involving the practice of professional engineering shall bear the stamp or seal and signature of a qualified engineer as required by the Engineering and Geoscientific Professions Act of the Province of Manitoba and By-laws of the Engineers Geoscientists Manitoba.

(b) Final design documents irrespective of the level of design shall bear an engineer's seal.

(c) Other reports and documents not involving the practice of professional engineering, such as letters of information and minutes of meetings, may be originated and signed by other personnel engaged by the Consultant and accepted by the City.

D6.1.2 Progress estimates, completion certificates, and other reports related to the technical aspects of this Project shall be endorsed by the Consultant's Representative in a manner acceptable to the City.

D6.1.3 The Consultant shall, at a minimum, utilize the most current industry standard sustainable practices and conform to the latest codes, standards, regulations, and legislative requirements in effect. The Consultant shall liaise with the Project Manager on the application of codes and standards.

(a) The Consultant shall not substitute or replace Key Personnel throughout the duration of the Project without the written approval of the Project Manager. Experience and qualification as specified in B11 shall be submitted for all requested substitute(s) and replacement(s).

D6.1.4 The Consultant shall coordinate with outside agencies as required to perform the Services. The Consultant shall confirm with the Project Manager the agencies that are being contacted prior to doing so.

D6.1.5 The following publicly available design guides and standards as indicated in Appendix C – Relevant Documents shall apply to the Services:

(a) City of Winnipeg Water & Waste Department Electrical Design Guide.

(b) City of Winnipeg Water & Waste Department Electrical Identification Standard.

(i) This standard is only applicable to new equipment. Existing equipment names shall be maintained as much as is practical to minimize impact to existing systems.

(c) City of Winnipeg Water and Waste Department Computer Assisted Drafting (CAD) and Geographic Information System (GIS) Standards.

D6.1.6 The Consultant shall coordinate access to the W&W facilities with the Project Manager.

D6.2 Project Deliverables

D6.2.1 Project Deliverables include but are not limited to the:

(a) updated project management plan as detailed in D8.2;

(b) DBPS P-D001A and P-D002A preliminary design report as detailed in D11.3;

(c) tender submission documents of the detailed design as detailed in D12 for:

(i) The Hurst RPS Chiller Replacement as described in D12.3; and

(ii) The MacLean and McPhillips RPS Natural Gas Engines Cooling Upgrades as described in D12.4.

D6.2.2 All Project Deliverables are to be delivered with a document lifecycle approach.

D6.2.3 Where possible, include all documents in a searchable PDF format.

D6.2.4 Unless otherwise indicated, the review period for Project Deliverables shall be a minimum of fifteen (15) Business Days.

(a) The City review of separate Project Deliverables shall not have overlapping timeframes.

D6.2.5 All Deliverables shall have incorporated the Consultant's internal quality procedures before being submitted to the City.

(a) All Deliverables shall be reviewed by representatives of the Consultant who is proficient in technical writing and technical drawings prior to being submitted to the City.

(b) Any Deliverables deemed by the City to be of poor quality shall be rejected and will be required to be revised and resubmitted at no additional cost to the City and shall not impact the timing of the Project schedule.

D6.2.6 The Deliverables shall be submitted in a substantially completed draft format for review prior to submittal as a final document.

(a) Draft versions of written documents shall be submitted in Microsoft Word 2010 (.docx) native format.

(b) All Deliverables shall be submitted to the Project Manager.

(c) All City review comments shall be considered and incorporated into the final version, as applicable.

D6.3 Drawings

D6.3.1 Drawings shall be prepared in accordance with the W&W's CAD-GIS Specifications.

D6.3.2 Drawings shall not be prepared using the City's GeoMedia and Google Earth screen captures and instead shall be prepared from the legal plans, certificates of title, as-built records, and topographic survey.

D6.3.3 Process, utility, and building Drawings shall have the following scales:

(a) Details: 1:1, 1:5, 1:10, or 1:20;

(b) Process plans, sections, and elevations: 1:10, 1:20, or 1:50;

(c) Utility and building plans, sections, and elevations: 1:10, 1:20, 1:50, or 1:100; and

(d) Panel layouts: recommended 1:4 or 1:10 maximum if required.

D6.3.4 All profile components of Drawings shall be in natural scale.

D6.3.5 Where existing systems are being modified, the existing Drawings shall be modified or superseded rather than creating a new partial drawing only showing the new work.

D6.3.6 All final Drawings shall be submitted in AutoCAD format version 2012, PDF, and in 11x17 hard copy format, unless otherwise specified.

D6.3.7 P&ID Drawings shall be in accordance with requirements indicated in Appendix F.

D6.3.8 The City shall provide Drawing numbers for all new Drawings that are generated. All references in the final Drawings shall reference the City's Drawing number not the Consultant's Drawing number.

D6.3.9 Provide a cross reference on the Drawings to other associated Drawings, whether new Drawings included with this Work or the available Historical Drawings.

D6.3.10 Draft Drawings to be submitted to the City for review and comment at 30%, 60%, and 90% completion. Comments shall be reviewed and incorporated into the final Drawings, as applicable.

D6.4 Technical Specifications

D6.4.1 The City of Winnipeg Standard Construction Specifications shall be used where applicable. The City of Winnipeg Construction Specification is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at www.winnipeg.ca/matmgt/Spec/Default.stm.

D6.4.2 The technical specifications for process, instrumentation, controls, and building upgrades shall follow the NMS format.

D6.4.3 The Consultant shall review with the City the special requirements for materials of construction and/or process which shall be incorporated into the technical specifications.

D6.4.4 Draft technical specifications to be submitted to the City for review and comment at 30%, 60%, and 90% completion. Comments shall be reviewed and incorporated into the final technical specifications, as applicable.

(a) Prior to submitting the draft technical specifications, submit two representative specification sections for City review and comments. All further technical specification sections shall incorporate the City's comments.

D6.5 Equipment List

D6.5.1 At all draft Drawing and specification submittals, submit a draft equipment list. A sample equipment list can be found in Appendix L. The City will provide comments on the draft equipment list. Comments shall be reviewed and incorporated into the final tender submission, as applicable.

D6.5.2 Have a meeting with City staff to determine:

(a) City staff training requirements for each piece of equipment;

(b) quantities if the work requires multiples of the same equipment with the same identification;

(c) spare parts requirements for each piece of equipment;

(d) submittal requirements (e.g. shop drawings, operations and maintenance information, product datasheets, etc.) for each piece of equipment; and

(e) lamicoid name and type for each piece of equipment.

D6.6 Submittal List

D6.6.1 At all draft specification submittals, submit a draft submittal list. A sample submittal list can be found in Appendix M. The City will provide comments on the draft submittal list. Comments shall be reviewed and incorporated into the final tender submission, as applicable.

D6.7 Design Calculations

D6.7.1 Calculations as indicated in Appendix H to be submitted to the City for review and comment. Comments shall be reviewed and incorporated into the final calculations, as applicable.

D6.8 Cost Estimates

D6.8.1 AACE Class 1 Cost Estimate

(a) Draft AACE Class 1 Cost Estimate to be submitted to the City for review and comment at 90% completion of technical specifications. Comments shall be reviewed and incorporated into the final AACE Class 1 Cost Estimate, as applicable.

(b) AACE Class 1 Cost Estimate to include at a minimum

(i) A list of all assumptions and exclusions for the estimate (e.g. currency exchange rates, labour rates; project delivery method, basis for labour hours, etc.);

(ii) line item take-offs for equipment, materials, and rentals showing the unit price, unit labour hours, and quantities. Material costs and labour hours to be extended out based on indicated quantities;

(iii) assumed base labour rates;

(iv) general condition costs including but not limited to bonding, insurance, permits, as-builts, shop drawings, and health & safety;

(v) mark-ups for general contractor, division trades, and sub-trades; and

(vi) MRST as applicable.

D6.8.2 AACE Class 3 Cost Estimate:

(a) Draft AACE Class 3 Cost Estimate to be submitted to the City for review and comment within the draft preliminary design report. Comments shall be reviewed and incorporated into the final AACE Class 3 Cost Estimate, as applicable.

(b) AACE Class 3 Cost Estimate to include at a minimum:

(i) a list of all assumptions and exclusions for the estimate (e.g. currency exchange rates, factored equipment costs; factored building costs, quality of construction, levels of redundancy, chemical costs, contractor overheads and profits, etc.);

(ii) a breakdown of costs by individual sections within the NMS divisions (e.g. pumps, switchgear, MCC, equipment housekeeping pad, etc.);

(iii) utility agency (i.e. Manitoba Hydro) costs;

(iv) construction General Conditions costs included as a percentage of overall division costs;

(v) contingency costs for potential risks broken down by item; and

(vi) MRST as applicable.

D6.9 Construction Schedule

D6.9.1 Prepare an estimated construction schedule for the implementation of the design, taking into consideration whether phased construction requirements will be required to maintain compliance with the City's operation of the system.

D6.9.2 Use the Three-Point Estimate analysis in the construction schedule to indicate the optimistic, likely, and pessimistic time lines for the tasks and show the anticipated task times.

D6.10 Construction Plan

D6.10.1 Provide a construction plan which addresses the Site constraints (e.g. buried Critical Infrastructure, etc.) and details the proposed construction sequence.

D6.10.2 The plan shall suitable for both City and contractor use.

D6.10.3 The construction plan shall consist of the following sections at a minimum:

(a) Introduction

(b) Construction Sequence and Schedule

(c) Controls to Maintain System Operations

(d) Temporary Construction Requirements

(e) Risk Analysis

D6.11 Automation Deliverables

D6.11.1 Automation deliverables as indicated in Appendix G- Automation Engineering Requirements to be submitted to the City for review and comment. Comments shall be reviewed and incorporated into the final documents, as applicable.

D6.12 Project Commissioning Plan

D6.12.1 Prepare a project commissioning plan to detail the commissioning processes, roles and responsibilities, commissioning specifications and objectives, procedures, verification and certification requirements, and documentation and acceptance criteria for the Project.

(a) Identify all work items requiring commissioning and include a control narrative.

(b) Determine the appropriate method to commission each process, system, and piece of equipment using the factors outlined in Appendix I Commissioning Approach and in Appendix J Commissioning Strategy.

(c) Clearly indicate the tasks required and the party responsible for each task.

(d) Include all disciplines and coordination between the disciplines.

(e) Include all pre-commissioning requirements.

(f) Include all phasing requirements.

(g) Integrate a project training plan within the project commissioning plan. Identify all operations and maintenance training requirements, the responsible party (contractor, Consultant, supplier, etc.) and an outline of the content of each training session. As part of the commissioning process, the Consultant shall provide resources to train City personnel on any areas of gaps that are not addressed by the other planned training providers.

(h) Include commissioning phasing plans to ensure continuous operation of Critical Infrastructure.

(i) Include verifications forms with the commissioning plan.

D6.12.2 Ensure the integration of contractor commissioning requirements into the tender package.

D6.12.3 The project commissioning plan may be produced in NMS style format.

D6.13 Asset Lists

D6.13.1 Develop and provide the following asset lists:

(a) decommissioned assets; and

(b) new assets.

D6.13.2 The information for new assets to include but not be limited to:

(a) W&W identification;

(b) manufacturer;

(c) model number;

(d) serial number; and

(e) Authority Having Jurisdiction (AHJ) registration number.

D6.13.3 The lists shall include any equipment, device, and/or instrumentation that requires regular maintenance, servicing, or calibration. Static devices typically do not need to be included in the asset list.

D6.14 Operation and Maintenance Manuals Requirements

D6.14.1 Review the submitted operations and maintenance manuals for usability and appropriateness.

D6.14.2 The Operations and Maintenance Manuals shall consist of the following:

(a) basis of design (prepared during the design phase);

(b) performance requirements (prepared during the design phase);

(c) as-built single line diagrams and P&IDs for systems;

(d) as-built instrumentation drawings, datasheets, and tables for systems;

(e) as-built control narratives for systems;

(f) as-built system setpoints;

(g) specific system operation calculations, as applicable;

(h) equipment schedules;

(i) operation and maintenance instructions for each system;

(j) test reports; and

(k) final approved shop drawings.

D6.15 Photographs

D6.15.1 All photographs submitted to the City as part of the Project shall include captions with the following information:

(a) date photograph was taken;

(b) location and orientation where the photograph was taken; and

(c) a brief description of what is depicted in the photograph.

D6.16 Meetings

D6.16.1 Schedule and chair Project meetings.

(a) Provide an agenda within two (2) Business Days prior to the meeting date.

(b) Provide meeting minutes using the City Project Management meeting template within five (5) Business Days of the meeting date.

(c) Meetings shall be held at the Winnipeg Drinking Water Treatment Plant, 1199 Pacific Avenue (Winnipeg, Manitoba), the Consultant's Winnipeg office, virtually, or any alternative site agreed upon by the Project Manager and the Consultant.

D6.16.2 The Consultant's instrumentation and controls/PLC integration leader or designated representative shall attend monthly coordination meetings with the City's instrumentation and controls personal during detailed design and the City's instrumentation and controls personal and the control subcontractor during construction and commissioning. The City Project Manager or designated representative to chair and provide minutes for the meetings.

D6.17 Design Basis Memorandum

D6.17.1 The Design Basis Memorandum (DBM) shall be one of the first documents prepared by the Consultant during the design phase, to establish the basic design parameters for the project going forward and shall include the following:

(a) a description of the Project.

(b) Project objectives.

(c) design criteria for each discipline including at a minimum the following:

(i) design codes;

(ii) design references, standards, and guidelines;

(iii) design parameters;

(iv) design strategies;

(v) material and equipment information;

(vi) design and construction features; and

(vii) unresolved issues.

D6.17.2 The DBM shall to be a living document with changes occurring throughout the work as new information becomes available and the design is refined.

D6.17.3 An example of a W&W DBM is included in Appendix N – Design Basis Memorandum Sample.

D7. SCOPE OF SERVICES

D7.1 The Services required under this Contract shall consist of the following phases:

(a) Project Management as outlined in D8;

(b) Historical Information Review and Stakeholder Engagement as outlined in D9;

(c) Geotechnical Engineering Services as outlined in D10;

(d) Preliminary Design as outlined in D11;

(e) Detailed Design and Tender as outlined as outlined in D12;

(f) Contract Administration - Non-Resident Services as outlined in D13;

(g) Contract Administration - Resident Services as outlined in D14;

(h) Commissioning Services as outlined in D15;

(i) As-Built Drawings as outlined in D16;

(j) Project Closeout as outlined in D17; and

(k) Additional Work Allowance as outlined in D18.

D7.1.1 As the Project encompasses multiple Sites, parallel teams may be required to deliver the Scope of the Services identified in D7.

D7.2 Unless otherwise stated, Appendix A – Definition of Professional Consultant Services shall be applicable to the provision of Professional Engineering Services for this Project. These services are specific to Detailed Design and Contract Administration Services.

D7.3 The Services required shall be in accordance with the City's Project Management Manual http://winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm#2 and templates http://winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm#4 . Notwithstanding the foregoing, the Consultant is being engaged by the City for its professional expertise; the Consultant shall bring to the Project Manager's attention any aspect of the City's Project Management Manual or templates which the Consultant is of the opinion is not consistent with good industry practice.

D8. PROJECT MANAGEMENT

D8.1 Plan, organize, secure, and manage resources to complete the phases outlined in D9 to D17.

D8.2 The City Project Manager has prepared a project management plan. Review and update the project management plan no later than fifteen (15) Business Days after Project award. The project management plan includes:

(a) Scope and Schedule

(i) Include the information required in B13.

(ii) Provide a Deliverable based Work Breakdown Structure (WBS) that identifies major elements relative to how the assignment will be managed and in terms of tangible and verifiable results (including milestones, critical triggers, Deliverables, etc).

(iii) Provide a Project schedule, listing all Project activities and milestones. Identify responsibilities, timelines, and dependencies for all activities and milestones

(iv) The approved schedule will be used as the Project baseline throughout the Project.

(v) Update and included the Project schedule with each Consultant Progress Report as described in D8.3. The updated Project schedule to include the % Work Complete for each task.

(b) Budget

(i) Include the information required in B9.

(ii) Include a description of the processes used to carry out earned value analysis such that the Project's performance can be measured against scope, schedule, and cost baselines.

(c) Quality Management

(i) Describe quality management methods used to address quality planning, quality assurance, and quality control for the following:

(i) field surveying procedures and controls;

(ii) data review, verification, and validation;

(iii) City reviews;

(iv) corrective action process; and

(v) quality assurance and control of Deliverables.

(d) Human Resources

(i) Describe the team organizational and management approach.

(ii) Include an organizational chart.

(e) Communication

(i) Describe communication interfaces (organizational, technical, and interpersonal) and the roles and responsibilities of each stakeholder.

(ii) Identify the processes that will be used to liaise with the City throughout the provision of the Services and to provide ample opportunity for input and review by the City's Project team.

(f) Change Management Plan

(i) Identify the schedule, quality, and budget impacts of any proposed changes.

(g) Quality Assurance and Control Plan

(i) Establish appropriate levels of review and approvals for all Project Deliverables.

(h) Risk Management Plan

(i) Update the risk management plan identifying risk event causes, risk event outcomes, degree of certainty, effects on Project objectives, severity of risk, response/action(s) to be undertaken, contingency plan, and associated costs to manage risks.

(ii) The risk management plan shall be documented using the City's spreadsheet template located on the City's Asset Management Program website located at: https://www.winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm#5. A draft risk management plan has been prepared by the City and will be provided to the Consultant.

(iii) Outline process for updating the risk management plan in various phases of the Project.

D8.3 Issue Consultant Progress Reports every sixty (60) Calendar Days after the pre-commencement meeting up to the Total Performance of the construction tender.

D8.3.1 The Consultant Progress Reports template is available on the City of Winnipeg Documents for City Asset Management Program website (https://www.winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm).

D8.3.2 If critical stages outlined in D25 are not achieved, submit Consultant Progress Reports every thirty (30) Calendar Days until the deliverables indicated in D12 are approved by the City. No additional fees will be contemplated for additional Consultant Progress Reports.

D8.4 Coordinate regular monthly Project meetings and provide minutes. The meetings shall be used to update the Project Manager on the status of the Project, review the deliverables and to discuss other project management issues.

D8.4.1 The meeting minutes template is available on the City of Winnipeg Documents for City Asset Management Program website (https://www.winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm).

D8.4.2 Meetings shall be held monthly during design stages up to the final tender posting.

D8.4.3 Schedule all of the regular monthly Project meetings within five (5) days of the pre-commencement meeting.

D8.4.4 If critical stages outlined in D25 are not achieved during the preliminary design and design stages, regular Project meeting frequency shall increase to every two weeks until the deliverables indicated in D12 are approved by the City. No additional fees will be contemplated for additional.

D8.4.5 The frequency of meetings may vary based upon the level of project activity.

D8.5 In addition to the regular Project meetings detailed in D8.4, schedule and chair the following meetings:

(a) pre-commencement meeting – to be scheduled immediately upon award of the Project;

(b) equipment list review meeting (as described in D6.5);

(c) stakeholder workshop (as described in D9.3);

(d) meeting to review the draft preliminary design report for DBPS (as described in D11);

(e) meeting to review the 60% draft Hurst RPS chiller upgrade tender documents (as described in D12.3.2;

(f) meeting to review the 30% and 60% MacLean RPS, and McPhillips RPS pump cooling upgrades tender documents (as described in D12.4.2);

(g) meeting to review the appraisal of each construction tender submission; and

(h) Project closeout meeting.

D8.5.1 Meetings can be combined if appropriate.

D8.6 Provide ten (10) Business Days notice prior to any Site visit or work that will require assistance from City personnel.

D8.7 Carry out other project management activities as required.

D9. HISTORICAL INFORMATION REVIEW AND STAKEHOLDER ENGAGEMENT

D9.1 Review all pertinent background information including, but not limited to:

(a) Historical Drawings;

(b) existing equipment shop drawings;

(c) existing operation and maintenance manuals; and

(d) operational data.

D9.2 Conduct detailed Site investigations of the DBPS and the RPSs to verify Historical Drawings and documents reviewed in D9.1 and to familiarize yourselves with the various Sites.

D9.2.1 Note any discrepancies from the Historical Drawings and documents reviewed in D9.1 to the Project Manager.

D9.2.2 Ensure such discrepancies are resolved for the final design Deliverables.

D9.3 Conduct a stakeholder workshop with City personnel.

D9.3.1 The purpose of the stakeholder workshop is to develop and review the Project basis, objectives, and criteria which shall be incorporated into the DBM, as described in D6.17. Topics to be discussed include but are not limited to:

(a) deficiencies and issues in the current systems;

(b) equipment selection for the new process systems;

(c) develop and review the DBM;

(d) operation and maintenance requirements of the new process systems; and

(e) constraints related to maintaining operation of the Critical Infrastructure during the construction period.

D9.3.2 A minimum of two stakeholder workshop to be conducted with a minimum duration of two hours each.

D9.3.3 Provide minutes of the stakeholder workshop and DBM within fifteen (15) Business Days of completion of the workshop.

D10. GEOTECHNICAL ENGINEERING SERVICES

D10.1 The Consultant shall provide the necessary geotechnical engineering services to determine the appropriate foundation systems for the Hurst RPS air cooled condenser, the MacLean RPS fluid coolers, and the McPhillips RPS fluid coolers.

D10.1.1 The geotechnical engineering services shall consist of the following activities:

(a) reconnaissance of the Sites with the City and the appropriate agents for utility locates prior to any sub-surface investigation.

(b) performance of a sub-surface investigations (including mobilization, site clean-up, and demobilization) in the vicinity of proposed construction locations.

(i) Clear above ground site obstacles (e.g. snow, minor vegetation, etc.) as required.

(ii) Soft dig any adjacent sub-surface utilities to confirm locations as required.

(iii) Collect soil samples at a maximum of 1.5 metre intervals or at changes in soil stratigraphy. Record other pertinent information such as sloughing and seepage. The number and type of tests conducted shall depend on the nature of materials encountered.

(iv) Backfill and restore boreholes, any excess soil cuttings to be disposed of off-site; and

(c) prepare a report(s) to summarize the Site conditions observed, the soil units encountered, and recommend suitable foundations in accordance with the National Building Code of Canada and Canadian Foundation Engineering Manual. The recommendation of any foundations shall factor in risks to nearby Critical Infrastructure (e.g. pumping station piping, Aqueduct, etc.) during construction.

D10.1.2 The north and west side of the McPhillips RPS Site has abandoned below grade structures that may be encountered.

D10.1.3 Foundation upgrades which requires extensive excavation and backfilling to the south side of Hurst RPS Site are currently underway.

D11. PRELIMINARY DESIGN

D11.1 Provide all necessary engineering services (e.g. process, civil, structural, mechanical, electrical, and instrumentation, etc.) as required to prepare a preliminary design for the DBPS P-D001A and P-D002A pumps and associated cooling systems upgrades to allow for continuous operation.

D11.2 Investigate, at a minimum, the following two options for the DBPS P-D001A and P-D002A pumps and associated cooling systems upgrades:

(a) replacement of current magnetic coupling systems with new inverter drives for the existing pump motors; and

(b) replacement of the existing cooling system for the existing magnetic coupling system with new fluid coolers selected for dry bulb design temperature of 40 degrees Celsius, backed up using potable water through a double wall plate and frame heat exchangers (or equivalent type of shell and tube or other heat exchanger).

D11.2.1 For each upgrade option considered, provide, at a minimum;

(a) a detailed description of the various components of the upgrade scenario, including all modifications that are required;

(b) a Class 5 Cost Estimate to complete the upgrades;

(c) a Class 5 Cost Estimate of the maintenance and operating costs of the associated option. The City will provide data regarding utility and labour costs to be assumed in the estimate;

(d) the total anticipated life expectancy of the upgrade option; and

(e) a tabulated comprehensive list of pros and cons for each option, including financially immeasurable benefits (e.g. increased safety, operational flexibility, etc.).

D11.2.2 Complete a life-cycle cost-benefit assessment of the upgrade options. Include the expected service life of each option, the electrical utility costs of operating the equipment, the cost of the maintenance work, and the cost of replacement (if applicable).

(a) Complete all tabs in the City's Net Present Value and Benefit Calculation template excluding the *"Benefits"* and the *"Status Quo"* tab. The City's Net Present Value and Benefit Calculation Template can be found at https://www.winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm. Before starting the task, the Consultant shall ensure the most recent version of the template is being used as the templates are updated on a regular basis.

D11.2.3 Make a recommendation as to the most advantageous DBPS P-D001A and P-D002A pumps and associated cooling systems upgrade option.

D11.3 Prepare and submit a draft preliminary design report based on the recommended DBPS P-D001A and P-D002A pumps and associated cooling systems upgrade option determined in D11.2.

D11.3.1 The preliminary design report at a minimum shall include:

(a) a general system description and preliminary control narrative;

(b) preliminary design Drawings including at a minimum;

(i) equipment layout drawings,

(ii) utility and process flow diagrams;

(iii) generic loop diagrams;

(iv) equipment selections;

(v) P&IDs;

(vi) electrical single line drawings;

(vii) structural foundation drawings; and

(viii) Site civil drawings, as applicable;

(c) materials of construction selections;

(d) major equipment lists:

(e) design calculations: and

(f) an AACE Class 3 Cost Estimate as described in D6.8.2.

D11.3.2 Prepare and submit the draft preliminary design report for review and acceptance by the City.

D11.3.3 Conduct a meeting with the City Project team to discuss the draft preliminary design report approximately fifteen (15) Business Days following the submission of the draft preliminary design report.

D11.3.4 Resubmit the final preliminary design report after incorporating City review comments and comments that arose during the review meeting in D11.3.3.

D12. DETAILED DESIGN AND TENDER

D12.1 The Consultant shall provide all necessary professional services as required to prepare the detailed designs and **two** tender submissions for the following two cooling upgrades:

(a) The Hurst RPS Chiller Replacement as described in D12.3; and

(b) The MacLean and McPhillips RPS Natural Gas Engines Cooling Upgrades as described in D12.4.

D12.2 The general requirements listed below shall apply to both detailed design and tender submissions listed in D12.1.

D12.2.1 The work associated with the creation of SCADA interfaces will be the responsibility of the City.

D12.2.2 Where necessary, conduct field surveys and investigations to verify the existing conditions and to supplement all available information. Notify the Project Manager if existing conditions are found to deviate from City records.

D12.2.3 The detailed design shall address technical and operational issues, reliability/redundancy and safety concerns, and all current applicable code requirements.

D12.2.4 Identify all permits necessary for construction and submit the applicable design summaries to the authority having jurisdiction.

D12.2.5 The detailed design and tender submissions shall include:

1. Drawings as described in D6.3;
2. Technical Specifications as described in D6.4;
3. training requirements;
4. Equipment Lists as described in D6.5;
5. Submission Lists as described in D6.6;
6. Design Calculations as described in D6.7;
7. identification of construction lay-down area(s);
    a. Lay down areas to be restored back to original condition;
8. AACE Class 1 Cost Estimate as described in D6.8.1;
9. Construction Schedule as described in D6.9;
10. Construction Plan as described in D6.10;
11. Automation Deliverables as described in D6.11; and
12. Project Commissioning Plan as described in D6.12; and
13. Operation and Maintenance Manuals Requirements as described in D6.14;

D12.2.6 Arrange for advertisement of the tender packages with the City's Materials Management Division.

(a) Provide appropriate response to bidders and advice to the City during the tender posting period.

(b) Issue addenda to the tender, as required.

(c) Arrange for and attend bidder's site visit(s).

(d) Evaluate the bids received and provide an award of contract recommendation letter.

(e) If the bids deviate more than 15% from the Class 1 Cost Estimate, provide justification for the difference in pricing in the award recommendation letter.

D12.3 Prepare a detailed design and a tender submission for the Hurst RPS Chiller Replacement.

D12.3.1 The scope of work for the Hurst RPS Chiller Replacement shall include but not be limited to:

(a) the replacement of the existing nominally rated 140 ton, R-22 water cooled chiller system at the Hurst RPS with a suitable alternative cooling system;
  (i) Calculate the facility cooling loads using climatic conditions suitable for critical infrastructure and when the Hurst RPS is operating at Firm Capacity;

(b) demolition of the existing systems as required for the installation of new systems including but not limited to the chiller, cooling tower, pumps (chilled water and cooling tower), foundations/housekeeping pads, cabling/conduit, MCC sections, coils, and existing HVAC control systems;

(c) installation of two new air-cooled condensing units, refrigerant piping systems, and new DX coils installed in the roof top air handling units;
  (i) For the air-cooled condensing units ensure the entire system has adequate capacity in the event of either independent system fails.

(d) modifications to the electrical distribution and MCC based on the changes necessary for the new cooling system;
  (i) It is anticipated that new electrical feeds to the equipment and breakers in the MCC's will be required.

(e) installation of instrumentation and monitoring upgrades for a new PLC based HVAC control system for chiller and air handling/exhaust fans monitoring and control; and

(f) installation of a new exterior equipment pads or foundations and subsequent regrading of the site;
  (i) Buried critical infrastructure and other utilities on the Sites must be considered during design.

D12.3.2 Conduct a meeting with the City Project team to discuss the 60% draft Hurst RPS chiller upgrade tender documents approximately fifteen (15) Business Days after the submission to the City. Topics to be discussed include but are not limited to:
  (i) addressing City review comments;
  (ii) anticipated construction costs; and
  (iii) anticipated constructability of the design.

D12.4 Prepare a detailed design and a tender submission for the MacLean and McPhillips RPS Natural Gas Engines Cooling Upgrades.

D12.4.1 The scope of work for the MacLean and McPhillips RPS Natural Gas Engines Cooling Upgrades shall include but not be limited to:

(a) installation of cooling upgrades to the five natural gas engine driven pumps at MacLean RPS and McPhillips RPS (MacLean RPS LG-042-PP-22 and LG-042-PP-26 and McPhillips RPS PG-043-PP-1, PG-043-PP-3, and PG-043-PP-5).
  (i) Cooling systems shall use closed loop fluid coolers/radiators for the primary and secondary cooling loops for each natural gas engine.
  (ii) The new cooling systems shall be backed up using the existing shell and tube heat exchangers.
  (iii) The new primary and secondary fluid cooling loops shall be sized for simultaneous operation of the three pumps (PG-043-PP-1, PG-043-PP-3, and PG-043-PP-5) at the McPhillips RPS and two pumps (LG-042-PP-22 and LG-042-PP-26) at the MacLean RPS.
  (iv) For fluid coolers and back up cooling heat exchangers provide one fluid cooler and heat exchanger per circuit per natural gas engine pump. The pipe

circuiting should be configured to allow circulation from any engine to any fluid cooler.

(v) For each RPS, provide a duty fluid circulation pump for each fluid cooler plus one standby fluid circulation pump for the system.

(vi) The system design shall provide for future consideration of heat recovery within the RPS during heating season operation.

(b) modifications to the normal power systems based on the requirements of the new cooling systems;

(c) installation of new instrumentation and automation to monitor and control new cooling systems; and

(d) installation of new exterior foundations for the closed loop fluid coolers/radiators.

(i) Consideration should be given to buried Critical Infrastructure and other utilities on the Sites.

D12.4.2 Conduct a meeting with the City Project team to discuss the 30% and 60% MacLean RPS, and McPhillips RPS pump cooling upgrades tender documents approximately fifteen (15) Business Days after the submission to the City. Topics to be discussed include but are not limited to:

(i) addressing City review comments;

(ii) anticipated construction costs; and

(iii) anticipated constructability of the design.

D13. CONTRACT ADMINISTRATION - NON-RESIDENT SERVICES

D13.1 Administer the construction contract(s).

D13.2 Use the appropriate City templates throughout the course of the Project. All documents can be found on the City's Infrastructure Planning Office website: https://www.winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm

D13.2.1 Relevant City templates include but are not limited to:

(a) pre-construction meeting agenda and meeting minutes;

(b) proposed change notice (PCN);

(c) PCN log;

(d) request for information (RFI);

(e) RFI log;

(f) field instruction;

(g) field instruction log;

(h) contract change log;

(i) change of work order (CWO);

(j) decision log;

(k) daily construction report;

(l) inspection report;

(m) meeting minutes;

(n) site meeting minutes;

(o) Certificate of Substantial Performance;

(p) Certificate of Total Performance; and

(q) Certificate of Acceptance.

D13.3 Conduct a pre-construction meeting with the contractor and provide minutes.

D13.4 Prepare and issue Construction Documents to the contractor after the award of the tenders.

D13.5 Coordinate with the contractor for completion of permits in a timely manner.

D13.5.1 Prepare the building and Site design summaries or similar documents authority requested documents for the permit applications.

D13.6 Review and accept contractor submittals.

D13.6.1 The review and acceptance of contractor submittals (i.e. shop drawings, safe work plan, etc.) shall be conducted by a Professional Engineer(s) of the appropriate discipline and any other associated or impacted disciplines.

D13.6.2 Provide one comprehensive review of each submittal that the contractor has stamped and submitted. Subsequent reviews of submittals shall be at the cost to the contractor.

D13.7 Review and report to the City on laboratory, shop, and other test results conducted upon materials and/or equipment.

D13.8 Review any alternate materials or methods that may be required to progress the work. No alternates shall be approved without written authorization from the City.

D13.9 Submit a copy of all correspondence relating directly or indirectly to the Project, originating from or distributed to parties external to the Consultant, immediately following receipt or dispatch by the Consultant.

D13.10 Coordinate and prepare PCN's regarding the contractor scope of work as required. This may include the preparation of specifications and Drawings for the PCN.

D13.11 Review extra work claims submitted by the contractor. Prepare and process CWO's accordingly in a timely manner.

D13.12 Review and respond to contractor RFIs in a timely manner.

D13.13 Prepare contractor site instructions/clarifications/directives as required.

D13.14 Interpret technical aspects of the Contract as requested by the City.

D13.15 Coordinate regular construction review meetings. The meetings shall include representatives of the City and the contractor. The meetings shall be used to update the City on the status of construction and to discuss any other construction related issues.

D13.15.1 The typical frequency of meetings shall be biweekly during the course of construction, although meeting frequency may vary based upon the level of construction activity.

D13.15.2 Prepare and distribute meeting minutes within three (3) Business Days. Update the meeting minutes with corrections from other parties. Items requiring immediate actions shall be emailed prior to issuance of the meeting minutes

D13.16 Prepare, certify, and submit progress estimates to the City for payment to the contractor for construction performed in accordance with the Drawings and specifications.

D13.17 Administer Substantial Performance with regards to the construction Contract.

D13.17.1 Coordinate and lead a comprehensive, detailed inspection prior to Substantial Performance, including the contractor and the City. Document and report on all issues identified and coordinate completion of the issues.

D13.17.2 Make a recommendation to the Project Manager when the contractor has achieved Substantial Performance.

D13.17.3 Act as Payment Certifier and administer all contracts as required under the Builder's Liens Act of Manitoba.

D13.17.4 Upon approval, prepare and issue a Certificate of Substantial Performance.

D13.18 Administer Total Performance with regards to the construction Contract.

D13.18.1 Coordinate and lead a comprehensive, detailed inspection prior to Total Performance, including the contractor and the City. Document and report on all issues identified and coordinate completion of the issues.

D13.18.2 Make a recommendation to the Project Manager when the contractor has achieved Total Performance.

D13.18.3 Upon approval, prepare and issue the Certificate of Total Performance.

D14. CONTRACT ADMINISTRATION - RESIDENT SERVICES

D14.1 Provide inspection services when the contractor is on-site to ensure that the construction conforms to the design Drawings and specifications.

D14.2 Visit and inspect work at fabrication shops, staging areas, and manufacturing facilities, as required.

D14.3 Provide weekly construction reports during the course of construction. The reports shall include, but not be limited to:

(a) working days and days lost due to unforeseen conditions the course of construction; and

(b) written and photographic records of the construction, including construction progress.

D14.4 Review contractor's redline drawings during the course of construction to ensure modification and changes implemented are reflected accurately.

D14.5 Keep a continuous record of Project activities including but not limited to the weekly construction reports, photographic record of construction work and equipment, working days, teleconferences, emails, inspections, and observations sufficient to equip the City to provide valid evidence and relevant testimony in settlement of any claim involving the City by any court of law, or by any other party for damages arising from the Project.

D14.6 Witness quality control procedures implemented by the contractor.

D14.7 Arrange for and carry out testing of materials utilized by the contractor.

(a) Notwithstanding C1.1(b), the cost to the Consultant for the provision of third-party testing, as authorized by the Project Manager, will be reimbursed as an Allowable Disbursement.

(b) The Consultant shall ensure that selected third-party services are provided at competitive market rates.

(c) Costs shall be substantiated by the provision of suitable documentation.

D14.8 Prepare, update, maintain, and coordinate a deficiency list of all issues identified during inspections. Coordinate remediation of the deficiency list with the contractor.

D15. COMMISSIONING SERVICES

D15.1 The Consultant is responsible for the planning and leadership of the overall commissioning activities to ensure that all commissioning activities are carried out and all equipment is fully operational upon completion of the Project. While the contractor and the City may perform specific commissioning tasks, this does not reduce or eliminate the Consultant's responsibilities.

D15.2 Schedule and coordinate all commissioning work in coordination with the contractor's schedule.

D15.3 Coordinate closely with the Project Manager and City operations personnel throughout the course of the commissioning process. Ensure that City operations personnel are always aware of the current commissioning status and any upcoming operational requirements or impacts.

D15.4 Prepare shutdown protocols for any activities requiring an operational shutdown of the RPSs.

D15.4.1 Shutdown protocols shall be submitted for City review allow a minimum of 20 Business Days in advance of any proposed operational shutdowns affecting the RPSs.

D15.4.2 Shutdown protocols which shall include:

(a) start time and estimated completion time,

(b) City resource requirements,

(c) a pre-shutdown checklist,

(d) activities necessary to remove from service any station components required to be de-energized in order to safely complete the work,

(e) identification of known risks to completing the work within the scheduled shutdown period and contingency plans to mitigate those risks,

(f) activities required to restore the system to service, and

(g) emergency contact information for key personnel involved in the shutdown.

D15.5 Document equipment deliveries and installations.

D15.6 Monitor commissioning activities, witness and certify the accuracy of the reported results.

D15.7 Coordinate, witness, and document equipment performance tests and process system performance tests.

(a) Ensure that the contractor completes the specified tests of the equipment and systems.

(b) Coordinate testing with contractor and ensure that the results are consistent with the system requirements.

(c) Where performance test results indicate an issue, coordinate with the contractor to resolve the issue(s).

(d) Coordinate and manage start-up and commissioning of new equipment and systems. This includes but is not limited to modifying the commissioning plan as required, planning and scheduling of commissioning work, co-ordination of City personnel, full time presence during commissioning work, review of contractor submissions, and record keeping.

D15.8 Sign off on all commissioning records.

D15.9 Coordinate with contractor to provide on-site training sessions and workshops to provide instruction to City staff on the safe operation of all new equipment including recommended maintenance tasks and schedules. The training provided by the contractor shall be in compliance with best practices for operations staff to earn continuing education credits.

D15.9.1 Training materials to be submitted for review and comment prior to the on-site training.

D15.10 Compile and hand over to the City all commissioning documentation, including but not limited to:

1. commissioning plans and procedures;

(a) evidence of commissioning verification;

(b) deficiency reports and corrective actions taken;

(c) training material and records; and

(d) any other commissioning documents.

D16. AS-BUILT DRAWINGS

D16.1 Prepare and submit draft As-Built Drawings within 45 Calendar Days of Total Performance of the construction contract.

D16.1.1 Submit electronic PDF copies of the draft As-Built Drawings for City review.

D16.1.2 All City review comments shall be considered and incorporated into the final version, as applicable.

D16.2 Upon receipt of City's acceptance of the As-Built Drawings, submit one (1) set of size A1 Mylar and one (1) electronic copy of PDF and AutoCAD files of the final As-Built Drawings.

D16.2.1 The AutoCAD files shall be in the City's current application version.

D16.2.2 Point cloud or other three-dimensional image files used for the creation of the documents shall be submitted to the City with the final As-Built Drawings.

D16.3 As-Built Drawings shall reflect Site verified as-constructed conditions, including contractor markups, contract change orders, RFI's, and markups from resident inspection of the work. Reliance solely on contractor markups without Site verification of as-constructed conditions is not satisfactory.

D16.3.1 References on the Drawings relating to the status of an object such as new or existing shall be changed to reflect the final construction state.

D16.3.2 Existing Historical Drawings that are either superseded, obsolete, or require revisions shall be identified to the City.

D16.3.3 All cross-reference Drawing numbers (e.g. sections, elevations, detail call-outs, etc.). on the As-Built Drawings shall reference the City drawing numbers and not the Consultant drawings numbers.

D16.4 As-Built Drawings shall be authenticated by the engineer-of-record in accordance with the Engineers and Geoscientists of Manitoba document entitled "Authentication of Hardcopy and Electronic Professional Documents."

D16.5 As-Built Drawings shall adhere to the General Requirements for Drawings as described in D6.3.

D17. PROJECT CLOSEOUT

D17.1 Confirm and ensure complete turnover of project documentation (shop drawings, As-Built Drawings, operations and maintenance manuals, spare parts, etc.) to the City by the contractor and verify that the documents are in conformance with the construction contract.

(a) Review the operation and operation and maintenance manuals to ensure they conform to the specification requirements.

D17.2 Provide a final construction report to the City within two months of Total Performance. The final construction report shall include the following:

(a) a brief summary of the project, including;
  (i) services accomplished, including the initial and final scope of the Project;
  (ii) issues encountered during the Project and the resolutions achieved; and
  (iii) final or projected final contract cost; and

(b) appendices, including:
  (i) photographs – typical pre-construction, during construction, and post-construction photographs;
  (ii) cost summary;
  (iii) tabulation of tenders;
  (iv) change orders;
  (v) summary of progress payments;
  (vi) final construction contract schedule;
  (vii) subcontractor list;
  (viii) daily or weekly reports;
  (ix) progress meeting minutes;

(x) shop drawings/submittals;
(xi) field instructions;
(xii) contractor RFI's and responses;
(xiii) material test reports;
(xiv) warranty information;
(xv) validation documentation;
(xvi) commissioning documentation;
(xvii) certificates of Substantial Performance and Total Performance; and
(xviii) Asset Lists described in D6.13.

D17.2.1 Submit two (2) paper copies and one (1) electronic PDF copy of the final construction report.

D17.3 Provide one (1) year warranty services tied to the date of Total Performance. The warranty services shall include but are not limited to the following:

(a) provision of inspection services, at the request of the City, during the warranty period of the construction contract to advise the City in writing of any deficiencies and the proposed resolution of the deficiencies. Upon approval of the City, provide the contractor appropriate notice to correct the deficiencies;

(b) determination if corrective work is part of contractor's warranty;

(c) liaison and coordination with the contractor to repair defective work;

(d) conduction of the inspection and approval of warranty work;

(e) issuance of instructions for correction of deficiencies;

(f) review of updates to operations and maintenance manuals and resolve deficiencies;

(g) respond to requests of the City related to the Project;

(h) coordinate and lead a comprehensive, detailed inspection prior to the expiration of the warranty period for construction, including the contractor and the City. Document and report on all issues identified and coordinate completion of the issues; and

(i) Prepare and issue the certificate of acceptance.

D18. ADDITIONAL WORK ALLOWANCE

D18.1 The Additional Work Allowance of seventy-five thousand ($70,000) dollars is to be used for changes in engineering services that arise due to unforeseen conditions with the Sites, if the existing documentation, and/or the Contract is at variance with any laws, ordinances, rules, regulations or codes of authorities having jurisdiction, or if changes are made to any laws, ordinances, rules, regulations and codes subsequent to the Submission Deadline which require modifications to the Contract. When these circumstances occur, the Consultant shall promptly provide notice thereof to the Project Manager, including:

(a) the description of the unforeseen condition;

(b) a detailed description of the proposed change in Services; and

(c) the Consultant's proposed method(s) to determine the adjustment, if any, to the Contract.

D18.2 Expenditures under the Additional Work Allowance shall be authorized by the Project Manager.

D18.3 Where the actual cost of the Additional Work Allowance exceeds the amount of the allowance, the Consultant shall be compensated for the excess incurred and substantiated plus the amounts outlined in C8.4. Where the actual cost of the Additional Work Allowance is less than the amount of the allowance, the City shall be credited for the unexpended portion of the allowance.

D19. SITE SECURITY

D19.1 Each individual proposed to perform Work under this Contract and within the DBPS and RPSs shall be required to obtain security clearances as described in E1.- Security Cleanances.

D19.2 The Consultant will be issued an access card or keys for access to the DBPS and the RPSs under the following conditions:

(a) the Consultant shall provide the name and contact information for the person in charge and responsible for the access card(s) or keys;

(b) the Consultant is to coordinate with the City on the number of cards or keys that will be required;

(c) the Consultant is to return all access cards or keys within thirty (30) Calendar Days after Total Performance for construction; and

(d) the Consultant is to immediately report any lost cards or keys and return any damaged or non-functioning cards or keys for replacement.

D19.2.1 The first invoice payment after issuing keys will be deducted one thousand dollars ($1,000.00) as a deposit for all keys.

D19.2.2 In the event all the keys including any damaged keys are not returned after thirty (30) Calendar Days from Total Performance for construction the deposit of one thousand dollars ($1,000) will be retained by the City.

D19.3 Additional protocols for accessing the Site will be provided at the pre-commencement \ meeting.

SUBMISSIONS

D20. AUTHORITY TO CARRY ON BUSINESS

D20.1 The Consultant shall be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed, or permitted by law to carry on business in Manitoba, or if the Consultant does not carry on business in Manitoba, in the jurisdiction where the Consultant does carry on business, throughout the term of the Contract, and shall provide the Project Manager with evidence thereof upon request.

D21. SAFE WORK PLAN

D21.1 The Consultant shall provide the Project Manager with a safe work plan at least twenty (20) Business Days prior to the commencement of any work on the Site.

D21.2 The safe work plan should be prepared and submitted in the format shown in the City's template which is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/safety/default.stm

D22. INSURANCE

D22.1 The Consultant shall procure and maintain, at its own expense and cost, insurance policies with limits no less than those shown below.

D22.2 As a minimum, the Consultant shall, without limiting its obligations or liabilities under any other contract with the City, procure and maintain, at its own expense and cost, the following insurance policies:

(a) Comprehensive or Commercial General Liability Insurance including:

(i) an inclusive limit of not less than two million dollars ($2,000,000.00) for each occurrence or accident with a minimum two million dollars ($2,000,000.00) Products

and Completed Operations aggregate and five million dollars ($5,000,000.00) general aggregate;

(ii) all sums which the Consultant shall become legally obligated to pay for damages because of bodily injury (including death at any time resulting therefrom) sustained by any person or persons or because of damage to or destruction of property caused by an occurrence or accident arising out of or related to the Services or any operations carried on in connection with this Contract;

(iii) coverage for Products/Completed Operations, Blanket Contractual, Consultant's Protective, Personal Injury, Contingent Employer's Liability, Broad Form Property Damage, Employees as Additional Insureds, and Non-Owned Automobile Liability;

(iv) a Cross Liability clause and/or Severability of Interest clause providing that the inclusion of more than one Insured shall not in any way affect the rights of any other Insured hereunder in respect to any claim, demand, suit or judgment made against any other Insured.

(b) if applicable, Automobile Liability Insurance covering all motor vehicles, owned and operated and used or to be used by the Consultant directly or indirectly in the performance of the Service. The limit of liability shall not be less than two million dollars ($2,000,000.00) inclusive for loss or damage including personal injuries and death resulting from any one accident or occurrence.

(c) Professional Errors and Omissions Liability Insurance including:

(i) an amount not less than five million dollars ($5,000,000.00) per claim and five million dollars ($5,000,000.00) in the aggregate.

D22.2.1 The Consultant's Professional Errors and Omissions Liability Insurance shall remain in force for the duration of the Project and for twelve (12) months after Total Performance.

D22.3 The policies required in D22.2(a) shall provide that the City is named as an Additional Insured thereunder and that said policies are primary without any right of contribution from any insurance otherwise maintained by the City.

D22.4 The Consultant shall require any Consultants hired to perform geo technical drilling and sample collecting or closed-circuit television to procure and maintain, at its own expense and cost, comparable insurance to that set forth under D22.2(a) and D22.2(b).

D22.5 The Consultant shall require each of its Subconsultants hired for design, architectural or engineering services as outlined in the Scope of Services to provide comparable insurance to that set forth under D22.2(a) and D22.2(c).

D22.6 The Consultant shall provide the Project Manager with a certificate(s) of insurance in a form satisfactory to the City Solicitor, at least two (2) Business Days prior to the commencement of any Services, but in no event later than the date specified in C4.1 for the return of the executed Contract. Such certificates shall state the exact description of the Services and provide for written notice in accordance with D22.9.

D22.7 The Consultant may take out such additional insurance as it may consider necessary and desirable. All such additional insurance shall be at no expense to the City.

D22.8 All insurance, which the Consultant is required to obtain with respect to this Contract, shall be with insurance companies registered in and licensed to underwrite such insurance in the Province of Manitoba.

D22.9 The Consultant shall not cancel, materially alter, or cause any policy to lapse without providing at least thirty (30) Calendar Days prior written notice to the City.

SCHEDULE OF SERVICES

D23. COMMENCEMENT

D23.1 The Consultant shall not commence any Services until it is in receipt of a notice of award from the City authorizing the commencement of the Services.

D23.2 The Consultant shall not commence any Services until:

(a) the Project Manager has confirmed receipt and approval of:

(i) evidence of authority to carry on business specified in D20;

(ii) evidence of the insurance specified in D22.

(b) the Consultant has attended a meeting with the Project Manager, or the Project Manager has waived the requirement for a meeting.

D23.3 The City intends to award this Contract by July 28, 2021.

D24. COVID-19 SCHEDULE DELAYS

D24.1 The City acknowledges that the schedule for this Contract may be impacted by the COVID-19 pandemic. Commencement and progress of the Services shall be performed by the Consultant with due consideration to the health and safety of workers and the public with directives from health authorities and various levels of government, and in close consultation with the Project Manager.

D24.2 If the Consultant is delayed in the performance of the Services by reason of the COVID-19 pandemic, the Services schedule may be adjusted by a period of time equal to the time lost due to such delay and costs related to such delay will be determined as identified herein.

D24.3 Within seven (7) Calendar Days of the award of Contract, the Consultant shall declare whether COVID-19 will affect the start date. If the Consultant declares that COVID-19 will affect the start date, the Consultant shall provide sufficient evidence that the delay is directly related to COVID19, including but not limited to evidence related to availability of staff or work by others.

D24.4 For any delay related to COVID-19 and identified after Services have commenced, the Consultant shall within seven (7) Calendar Days of becoming aware of the anticipated delay declare the additional delay and shall provide sufficient evidence as indicated in D24.3. Failure to provide this notice will result in no additional time delays being considered by the City.

D24.5 Any time or cost implications as a result of COVID-19 and in accordance with the above, as confirmed by the Project Manager, shall be documented in accordance with C8.

D25. CRITICAL STAGES

D25.1 The Consultant shall achieve critical stages of the Services for this Contract in accordance with the following requirements:

(a) DBPS preliminary design report by November 30, 2021;

(b) tender posting of the Hurst RPS Chiller Replacement by January 7, 2022; and

(c) tender posting of the DBPS Magnetic Drive Cooling Upgrade and the MacLean and McPhillips RPS Natural Gas Engines Cooling Upgrades by June 30, 2022.

THIRD PARTY AGREEMENTS

D26. FUNDING AND/OR CONTRIBUTION AGREEMENT OBLIGATIONS

D26.1 In the event that funding for the Services of the Contract is provided to the City of Winnipeg by the Government of Manitoba and/or the Government of Canada, the following terms and conditions shall apply, as required by the applicable funding agreements.

D26.2 Further to D26.1, in the event that the obligations in D26 apply, actual costs legitimately incurred by the Consultant as a direct result of these obligations ("Funding Costs") shall be determined by the actual cost to the Consultant and not by the valuation method(s) outlined in C7.4. In all other respects Funding Costs will be processed in accordance with Changes in Services under C7.

D26.3 For the purposes of D26:

(a) **"Government of Canada"** includes the authorized officials, auditors, and representatives of the Government of Canada; and

(b) **"Government of Manitoba"** includes the authorized officials, auditors, and representatives of the Government of Manitoba.

D26.4 Modified Insurance Requirements

D26.4.1 If not already required under the insurance requirements identified in D22, the Consultant will be required to obtain and maintain professional liability insurance in an amount of no less than one million dollars ($1,000,000.00) inclusive per claim. Such policy shall be maintained for at least twenty four (24) months after Total Performance.

D26.4.2 The Consultant shall obtain and maintain third party liability insurance with minimum coverage of two million dollars ($2,000,000.00) per occurrence on all licensed vehicles operated at the Site. In the event that this requirement conflicts with another licensed vehicle insurance requirement in this Contract, then the requirement that provides the higher level of insurance shall apply.

D26.4.3 Further to D22.6 insurers shall provide satisfactory Certificates of Insurance to the Government of Manitoba prior to commencement of Services as written evidence of the insurance required. The Certificates of Insurance must provide for a minimum of thirty (30) days' prior written notice to the Government of Manitoba in case of insurance cancellation.

D26.4.4 All policies must be taken out with insurers licensed to carry on business in the Province of Manitoba.

D26.5 Indemnification By Consultant

D26.5.1 In addition to the indemnity obligations outlined in C13 of the General Conditions for Consultant Services, the Consultant agrees to indemnify and save harmless the Government of Canada and the Government of Manitoba and each of their respective Ministers, officers, servants, employees, and agents from and against all claims and demands, losses, costs, damages, actions, suit or other proceedings brought or pursued in any manner in respect of any matter caused by the Consultant or arising from this Contract or the Services, or from the goods or services provided or required to be provided by the Consultant, except those resulting from the negligence of any of the Government of Canada's or the Government of Manitoba's Ministers, officers, servants, employees, or agents, as the case may be.

D26.6 Records Retention and Audits

D26.6.1 The Consultant shall maintain and preserve accurate and complete records in respect of this Contract and the Services, including all accounting records, financial documents, copies of contracts with other parties and other records relating to this Contract and the Services during the term of the Contract and for at least six (6) years after Total

Performance. Those records bearing original signatures or professional seals or stamps must be preserved in paper form; other records may be retained in electronic form.

D26.6.2 In addition to the record keeping and inspection obligations outlined in C7.16 of the General Conditions for Consultant Services, the Consultant shall keep available for inspection and audit at all reasonable times while this Contract is in effect and until at least six (6) years after Total Performance, all records, documents, and contracts referred to in D26.6.1 for inspection, copying and audit by the City of Winnipeg, the Government of Manitoba and/or the Government of Canada and their respective representatives and auditors, and to produce them on demand; to provide reasonable facilities for such inspections, copying and audits, to provide copies of and extracts from such records, documents, or contracts upon request by the City of Winnipeg, the Government of Manitoba, and/or the Government of Canada and their respective representatives and auditors, and to promptly provide such other information and explanations as may be reasonably requested by the City of Winnipeg, the Government of Manitoba, and/or the Government of Canada from time-to-time.

D26.7 Other Obligations

D26.7.1 The Consultant consents to the City providing a copy of the Contract Documents to the Government of Manitoba and/or the Government of Canada upon request from either entity.

D26.7.2 If the Lobbyists Registration Act (Manitoba) applies to the Consultant, the Consultant represents and warrants that it has filed a return and is registered and in full compliance with the obligations of that Act, and covenants that it will continue to comply for the duration of this Contract.

D26.7.3 The Consultant shall comply with all applicable legislation and standards, whether federal, provincial, or municipal, including (without limitation) labour, environmental, and human rights laws, in the course of providing the Services.

D26.8 The Consultant shall properly account for the Services provided under this Contract and payment received in this respect, prepared in accordance with generally accepted accounting principles in effect in Canada, including those principles and standards approved or recommended from time-to-time by the Chartered Professional Accountants of Canada or the Public Sector Accounting Board, as applicable, applied on a consistent basis.

PART E - SECURITY CLEARANCE

E1. SECURITY CLEARANCE

E1.1 Each individual proposed to perform Services under this Contract and within the Winnipeg Drinking Water Treatment Plant and associated facilities, the Regional Pumping Stations and associated reservoir structures and facilities, the Tache Booster Pumping Station or Shoal Lake Aqueduct Intake Facility shall be required to obtain a Global Sanctions & Politically Exposed Persons Check and a Police Information Check as detailed below.

E1.1.1 The Global Sanctions & Politically Exposed Persons Check must be obtained through Sterling BackCheck.

(a) A Sterling BackCheck account must be setup seventy-two (72) hours prior to individual security clearances to allow sufficient time for activation of the contracting company's account. If the contracting company has an existing City of Winnipeg Sterling Backcheck vendor account, they may skip to (d) below.

(b) An authorized individual of the contracting company must complete the Sterling Backcheck Setup Form. Click on the link below, complete the form, and hit submit. **(This form is to be completed by the company, not by the employee requiring the security clearances). https://forms.sterlingbackcheck.com/partners/platform2-en.php?&partner=winnipegcity

(c) Within forty-eight (48) hours of completing the Sterling Backcheck Setup Form, the authorized individual of the contracting company will receive a username and password for Sterling Backcheck. It will appear in their inbox as a "Welcome to Sterling Backcheck" e-mail. Upon receipt, the authorized individual of the contracting company will be asked to login to the Sterling Backcheck website to set their security questions and password. Once completed, individual security clearance requests can be submitted.

(d) In order to run a Global Sanctions & Politically Exposed Persons Check and/or a Police Information Check, follow the steps below:

(i) click on the sub-tab labelled "Order eConsent";

(ii) fill out the required information about the employee proposed to perform Services under this Contract within City facilities (the person that requires the security clearances);

(iii) select your location under the "Order Information" section and enter the organization's phone number, if required;

(iv) select the required individual service(s) in the dropdown menu under the "Select Services" section. If both the Global Sanctions & Politically Exposed Persons Check and the Police Information Check are required, select the Sterling Backcheck Package One (with electronic identity verification). Once selected, both the Global Sanctions & Politically Exposed Persons Check and the Police Information Check should have a grey check mark beside them;

(v) Scroll down to the bottom and click the blue "Submit" button. The employee proposed to perform Services under this Contract within City facilities will be invited to complete their security clearance;

(vi) The employee will receive the invitation and must click on the link and complete their Global Sanctions & Politically Exposed Persons Check and/or Police Information Check;

(vii) The results of the Global Sanctions & Politically Exposed Persons Check and/or Police Information Check will go directly to the City of Winnipeg and to the authorized individual of the contracting company within twenty-four (24) hours; and

(viii) contact Ron Risley at 204-986-3758 if you have any questions regarding the Global Sanctions & Politically Exposed Persons Check.

(e) Any questions related to the Sterling BackCheck process can be directed to Linda Ferens at 204-999-0912 or by email at: linda.ferens@sterlingcheck.com OR managedsupport@sterlingcheck.com

E1.1.2 The Police Information Check must be obtained from one of the following:

(a) Sterling BackCheck;

(i) see E1.1.1(a) thru (e) for instructions on how to set up an account and submit individuals for security checks; or

(b) a police service having jurisdiction at his/her place of residence;

(i) the original Police Information Check (Form P–612) will be provided by the Winnipeg Police Service to the individual applicant. The original has a validation sticker from the Winnipeg Police Service in the top right hand corner;

(ii) the applicant shall provide the original Police Information Check (Form P–612) to the Contract Administrator; or

(c) Commissionaires (Manitoba Division);

(i) forms to be completed can be found on the website at: https://www.commissionaires.ca/en/manitoba/home

(ii) the applicant shall provide the original Police Information Check to the Contract Administrator; or

(d) FASTCHECK Criminal Record & Fingerprint Specialists;

(i) forms to be completed can be found on the website at: https://myfastcheck.com

(ii) the applicant shall provide the original Police Information Check to the Contract Administrator.

E1.2 Any individual for whom a Global Sanctions & Politically Exposed Persons Check and/or a Police Information Check is not provided will not be permitted to perform any Services.

E1.3 Individuals for whom a Global Sanctions & Politically Exposed Persons Check indicates “CLEAR” and a Police Information Check demonstrates no previous convictions or pending charges will be permitted to perform Services as specified in E1.1.

E1.4 Individuals for whom a Global Sanctions & Politically Exposed Persons Check does not indicate “CLEAR” and/or a Police Information Check demonstrates previous convictions or pending charges may not be permitted to perform any Services as specified in E1.1.

(a) Previous convictions or pending charges may be investigated and a determination will be made by the City as to whether the individual will be permitted to perform any Services.

(b) Convictions or pending charges that may preclude an individual from performing any Services include but are not limited to:

(i) convictions or pending charges related to property offences; and/or

(ii) convictions or pending charges related to crimes against another person.

(c) Where additional investigation related to a Global Sanctions & Politically Exposed Persons Check or a Police Information Check is required by the City, no extension to critical stages, Substantial Performance, or Total Performance, as applicable, will be provided.

(d) Additional investigation by the City may take upwards of six (6) weeks.

E1.5 Prior to the award of Contract, and during the term of the Contract, if additional or replacement individuals are proposed to perform Services within City facilities, the Contractor shall supply the Contract Administrator with a Global Sanctions & Politically Exposed Persons Check and a Police Information Check satisfactory to the City obtained not earlier than one (1) year prior to the Submission Deadline, or a certified true copy thereof, for each individual proposed to perform the Services.

E1.6 Any Global Sanctions & Politically Exposed Persons Check and Police Information Check determined to be satisfactory to the City will be deemed valid for the duration of the Contract subject to a repeated records search as hereinafter specified.

1.1.1 Notwithstanding the foregoing, at any time during the term of the Contract, the City may, at its sole discretion and acting reasonably, require an updated Global Sanctions & Politically Exposed Persons Check and/or a Police Information Check. Any individual who fails to provide a Global Sanctions & Politically Exposed Persons Check and/or a Police Information Check satisfactory to the City as a result of a repeated records search will not be permitted to continue to perform any Services as specified in E1.1.

APPENDIX A – DEFINITION OF PROFESSIONAL CONSULTANT SERVICES

(a) INTRODUCTION

a. It is the intent of the City of Winnipeg, in defining Professional Consultant Services (Consulting Engineering Services), to clarify the role required of consulting Engineers; to more fully identify the services to be rendered by consulting Engineers to the City and to other parties on behalf of the City; and to provide a more clearly determined basis of obligation in respect thereof by consulting Engineers to the City and to third parties in the provision of such services

b. The services shall be performed in the City of Winnipeg, unless otherwise authorized by the City, under direct supervision of a professional Engineer. All drawings, reports, recommendations and other documents, originating therefrom involving the practice of professional engineering, shall bear the stamp or seal and signature of a qualified Engineer as required by the Engineering and Geoscientific Professions Act of the Province of Manitoba and By-laws of the Association of Professional Engineers and Geoscientists of the Province of Manitoba. Other reports and documents not involving the "practice of professional engineering", such as letters of information, minutes of meetings, construction progress reports, may be originated and signed by other responsible personnel engaged by the consulting Engineer and accepted by the City. Progress estimates, completion certificates and other reports related to the technical aspects of a project, must be endorsed by the Engineer in a manner acceptable to the City.

(b) ADVISORY SERVICES

a. Advisory services are normally not associated with or followed by preliminary design and/or design services, and include, but are not limited to:

(a) Expert Testimony;
(b) Appraisals;
(c) Valuations;
(d) Rate structure and tariff studies;
(e) Management services other than construction management;
(f) Feasibility studies;
(g) Planning studies;
(h) Surveying and mapping;
(i) Soil mechanics and foundation engineering;
(j) Inspection, testing, research, studies, or reports concerning the collection, analysis, evaluation; and
(k) Interpretation of data and information leading to conclusions and recommendations based upon specialized engineering experience and knowledge.

(c) PRELIMINARY DESIGN

a. Preliminary design services are normally a prelude to the detailed design of a project and include, but are not limited to:

(a) Preliminary engineering studies;
(b) Engineering investigation;
(c) Surface and subsurface site explorations, measurements, investigations, and surveys;
(d) Operations studies including drainage studies, traffic studies, etc.;
(e) Functional planning;
(f) Physical, economical (capital and operating) and environmental studies including evaluation, comparison, and recommendation regarding alternative preliminary designs;
(g) Preparation and submission of a report and appropriate drawings to the City, fully documenting data gathered, explaining adequately the assessment made, stating with clarity

the resulting conclusions, and containing all recommendations which are relevant to this stage of project implementation;

(l) Special applications to public agencies for necessary authorizations, preparation and submission of reports and drawings thereto and appearance before same in support of the application.

(d) **DETAILED DESIGN**

a. Detailed design services normally involve preparation of detailed designs, tender specifications and drawings, and analysis of bids and recommendations for contract award, and include, but are not limited to:

(a) Addressing alternative methods of accommodating; relocating; avoiding, and/or avoiding injury to Utilities and railways; proposing alternative methods of solution, reviewing same with the appropriate Regulatory approval agencies and stakeholders;
(b) Application to public agencies for necessary authorizations, preparation and submission of reports and drawings thereto, and appearance before same in support of the application;
(c) Preparation and submission of detailed engineering calculations, drawings, and criteria employed in the design(s), securing review of and an acceptance by the City;
(d) Preparation of detailed engineering drawings, specifications and tender documents consistent with the standards and guidelines of the City, securing review of acceptance by the City;
(e) Preparation and provision to the City in written form, a fully detailed formal construction contract estimate;
(f) Provision of appropriate response to bidders and advice to the City during the bid period and, subject to acceptance by the City, issuing addenda to the tender documents;
(g) Submission of a review, analysis, comparison, tabulation, calculation, and evaluation of the bids received, to the City;
(m) Preparation of a report including revised contract estimate, identifying and explaining variations from the earlier formal estimate, and containing recommendation regarding contract award identifying the reasons therefore.

(e) **CONTRACT ADMINISTRATION SERVICES**

a. Contract administration services are associated with the construction of a project and include the office and field services required to ensure the conduct of the project in accordance with the intent of the City and in conformance with the particulars of the drawings and specifications; and include but are not limited to:

NON-RESIDENT SERVICES

i. Consultation with and advice to the City during the course of construction;
ii. Review and acceptance of shop drawings supplied by the contractor or supplier to ensure that the drawings are in conformance with the drawings and specifications, without relieving the contractor of his contractual and other legal obligations in respect thereof;
iii. Review and report to the City upon laboratory, shop and other tests conducted upon materials and/or equipment placed or installed by the contractor to ensure to the City conformance with the drawings and specifications, without relieving the contractor of his contractual and other legal obligations in respect thereof;
iv. Acceptance of alternate materials and methods, subject to prior acceptance by the City, without relieving the contractor of his contractual and other legal obligations in respect thereof;
v. Provision to the City of a complete current report on the project status on a monthly basis;
vi. Provision to the City a current update of revised contract-end cost estimate on a monthly basis, or more frequently if found necessary,

with explanation and justification of any significant variation from the preceding contract-end cost estimate;

vii. Definition and justification of an estimate of cost for additions to or deletions from the contract for authorization by the City;

viii. Furnishing the City with a copy of all significant correspondence relating directly or indirectly to the project, originating from or distributed to, parties external to the consulting Engineer, immediately following receipt or dispatch of same by the consulting Engineer;

ix. Provision of adequate and timely direction of field personnel by senior officers of the Consultant;

x. Establishment prior to construction and submission to the City of written and photographic records of, and assessment of the physical condition of adjacent buildings, facilities, and structures sufficient to equip the consulting Engineer to provide valid evidence and relevant testimony in settlement of any claim involving the City by any court of law, or by any other party for damages thereto arising from the project;

xi. Arranging and attending pre-construction meetings and on-site or off-site review meetings, which meetings shall include representatives of the contractor and the City;

xii. The preparation and submission of:

(a) a detailed design notes package including items such as structural geotechnical, hydraulic and heating, air-conditioning and ventilation design calculations; mechanical and electrical design calculations related to process equipment and building services; process design calculations; and instrumentation and process control design calculations;
(b) approved related shop drawings and equipment process manuals all within one (1) month of completion of each separate installation contract required to complete the Works.

RESIDENT SERVICES

Provision of qualified resident personnel acceptable to the City present at the project site to carry out the services as specified immediately below, without relieving the contractor of his contractual and other legal obligations in respect thereof:

1 inspection of all pipe prior to installation;
2 inspection and acceptance of excavation for, and full time inspection at the time of bedding placement, pipe laying and backfilling in respect of installation of watermains, land drainage sewers, and wastewater sewers;
3 inspection of installation of all connections to watermains, sewers, manholes, valves, hydrants or house services, and excavation and/or exposing of all underground services, structures, or facilities;
4 "full time inspection" and/or testing of watermains and sewers;
5 inspection of all excavations to determine soil adequacy prior to installation of base and subbase courses for sidewalks, public back lanes, and street pavements. It is to be understood that "full time inspection" will require assignment of a qualified person to each specific location when the referenced work is being undertaken by the contractor.

Without relieving the contractor of his contractual and other legal obligations in respect thereof, conduct detailed inspection of construction sufficient to ensure that the construction carried out by the contractor is in conformance with the drawings and specifications;
Co-ordination and staging of all other works on the project site including traffic signal installations, hydro, telephone, and gas utility work, railway work forces and City or developer work;
In conjunction with the City, provision of notice to adjacent residents and businesses of those stages of construction of the project that will interrupt public services or access thereto, sufficiently in advance of same to permit preparation therefore;

Enforcement of contractor conformance with the City of Winnipeg Manual of Temporary Traffic Control in Work Areas on City Streets and with reasonable standards of safety for motorists and pedestrians, without relieving the contractor of his contractual and other legal obligations in respect thereof;
Provision of reference line and elevation to the contractor and checking upon the contractor's adherence thereto, without relieving the contractor of his contractual and other legal obligations in respect thereof;
Responsible, sensitive, and prompt reaction to the reasonable requests and complaints of citizens regarding the conduct of the project, acting in the interest of the City;
Arranging for and carrying out of testing of materials utilized by the contractor to ensure conformance with the drawings and specifications, without relieving the contractor of his contractual and other legal obligations in respect thereof;
Preparation, certification, and prompt submission of progress estimates to the City for payment to the contractor for construction performed in accordance with the drawings and specifications;
Arrange, attend and prepare and distribute records of and minutes for, regularly held on-site or offsite project review meetings including representatives of the contractor and the City;
Promptly reporting to the City upon any significant and unusual circumstances;
Promptly arranging for and taking part in a detailed final inspection of the project with the contractor and the City prior to commencement of the period of contractor maintenance guarantee specified in the contract for the project and providing to the City in written form an appropriate recommendation of acceptance of the constructed or partially constructed project;
Act as Payment Certifier and administer all contracts as required under the Builder's Liens Act of Manitoba;
Prepare a Certificate of Substantial Performance;
Preparation and submission to the City of "as-constructed" drawings for the project within 1 month of project completion;
Prepare a Certificate of Total Performance;
Provision of inspection services during the maintenance guarantee period of the contract;
Undertake a detailed inspection of the project with the contractor and the City prior to the end of the period of contractor maintenance guarantee specified in the contract for the project;
Keep a continuous record of working days and days lost due to inclement weather during the course of contract works;
Prepare a Certificate of Acceptance.

(f) **ADDITIONAL SERVICES**

a. Additional services are in addition to those specified in other Types of Services and may or may not be associated with a construction project, but are not in place of or in substitution for those services elsewhere specified in the Definition of Standard Consulting Engineering Services in respect of other Types or Categories of Services.

PART B - Revision of completed, or substantially completed, drawings and/or specifications that were in conformance with the original intent of the City or had been accepted by the City;
PART C - Preparation of operating manuals and/or training of operating personnel;
PART D - Startup and/or operation of operating plants;
PART E - Procurement of materials and equipment for the City;
PART F - Preparation for and appearance in litigation on behalf of the City;
PART G - Preparation of environmental studies and reports and presentation thereof in public hearings.

APPENDIX B – DEACON BOOSTER PUMPING STATION OBSERVERED AVERAGE FLOWS

Observed Average Flow Rates in Branches I and II (15 minute intervals)					
Observed Average Flow Rate Range (MLD)		Observed Average Flow Rate Range (L/s)		Number of Observed Occurences	Overall Yearly Percentage of Reported Data
0	10	0	116	237	0.96%
10	20	116	231	5	0.02%
20	30	231	347	7	0.03%
30	40	347	463	10	0.04%
40	50	463	579	8	0.03%
50	60	579	694	8	0.03%
60	70	694	810	4	0.02%
70	80	810	926	4	0.02%
80	90	926	1042	6	0.02%
90	100	1042	1157	6	0.02%
100	110	1157	1273	11	0.04%
110	120	1273	1389	1	0.00%
120	130	1389	1505	10	0.04%
130	140	1505	1620	7	0.03%
140	150	1620	1736	3	0.01%
150	160	1736	1852	23	0.09%
160	170	1852	1968	1,023	4.15%
170	180	1968	2083	4,664	18.92%
180	190	2083	2199	10,792	43.77%
190	200	2199	2315	4,908	19.91%
200	210	2315	2431	2,651	10.75%
210	220	2431	2546	113	0.46%
220	230	2546	2662	113	0.46%
230	240	2662	2778	43	0.17%
240	250	2778	2894	0	0.00%
250	400	4167	4630	0	0.00%

Based on data from DBPS operation September 1, 2019 to August 31, 2020

APPENDIX C – RELEVANT DOCUMENTS

The following documents are available for review by request to the Project Manager after the Contract award and the completion of a Non-Disclosure Agreement:		
1	**Facility Asbestos Surveys**	
	Author: Pinchin Environmental Ltd. Published: 2019	
2	**Hurst Water Pumping Station HVAC Upgrading**	
	Author: E.J. Faraci & Associates Ltd. Published: 1992	Functional design report of the McPhillips HVAC systems TD 485 .F3 1992A
3	**Upgrading of the HVAC Systems at the Hurst and MacLean Water Pumping Stations**	
	Author: Derksen Pluming and Heating Published: 1993	Operations and Maintenance manuals TD 485.F3 1994
4	**Construct G.C. MacLean Pumping Station and McPhillips Pumping Station upgrade [W-371; PD 97-115] : Supply, Delivery, and Supervision of the Installation of a Gas Engine, Pump And Related Equipment, Contract No. 3**	
	Author: Reid Crowther Partners Limited Published: 1998	Construction specifications TA 180.S658 1998 No. 03
5	**Construct G.C. MacLean Pumping Station and McPhillips Pumping Station Upgrade [W-372; PD 97-116] : Installation of Pumping, Mechanical, Electrical, and Related Equipment, Contract No. 4**	
	Author: Reid Crowther Partners Limited Published: 1998	Construction specifications TA 180.S658 1998 No. 02
6	**Maclean Pumping Station Operation and Maintenance Manual for Waukesha Model F3524GSI / Derksen Mechanical Services Inc.**	
	Author: Derksen Mechanical Services Inc. Published: 2010	Operations and Maintenance manuals REPO TD 725 .M355 D475 2010 NO. 01 V.1 REPO TD 725 .M355 D475 2010 NO. 02 V.1 REPO TD 725 .M355 D475 2010 NO. 03 V.1
7	**Operation & maintenance : City of Winnipeg, Cat G3512SITA 775 BHP @ 1200 RPM, IW 8141. Volume II**	
	Author: Catepillar Published: 1999	Operations and Maintenance manuals TD 725 .C38 1999
8	**Catepillar Operation and Maintenance Manual : G3508, G3512 and G3516 engines**	
	Author: Catepillar. Published: 1998	Operations and Maintenance manuals TD 725 .C38 1999
9	**Rebuild of Two (2) Existing Waukesha VLRO 5790 Engines at the McPhillips Pumping Station (Bid opportunity No. 874-2008)**	
	Author: Catepillar. Published: 2009	Construction Documentation TA 180.S658 2008 NO.15
10	**Supply, Delivery, Installation and Commissioning of Natural Gas Engine Drive 26 at the MacLean Pumping Station (Bid Opportunity No. 839-2008)**	
	Author: AECOM Published: 2009	Construction Documentation TA 180.S658 2008 NO.25
11	**Waukesha ESM VHP Series Four 7042 GL/GSI Engine System Manager**	
	Author: Dresser Inc. Published: 1997	Operation and Maintenance manual TEXT TD 725.M335 D747 1997

12	**Waukesha VHP series four with ESM**	
	Author: Dresser Inc. Published: 2005	Operations and Maintenance manuals TEXT TD 725.M335 D747 2005
13	**Construct the Deacon Booster Pumping Station, west of Deacon Road and south of G.W.W.D. Railway in the Rural Municipality of Springfield, and associated works as specified, in accordance with specific**	
	Author: James f. MacLaren Limited Published: 1978	Construction Documents TA 180.S658 1978 NO.02
14	**Deacon Water Treatment Program – Supply of Deacon Booster Pumps**	
	Author: Power & Mine Supply Co. Ltd. Published: 2005	Operations and Maintenance manuals REPO TD 434.P694 2005-02
15	**MacLean Pumping Station Arc Flash Study**	
	Author: SNC Lavalin Published: 2011	Arc flash and coordination study and electronic data files REPO TK 152.A7 2011-01 MRDF TK 152.A7 2011-01A
17	**McPhillips Pumping Station Arc Flash Study**	
	Author: SNC Lavalin Published: 2013	Arc flash and coordination study and electronic data files REPO TK 152 A7 2011-04 MRDF TK 152.A7 2011-04A
18	**Deacon Booster Pumping Station Arc Flash Study**	
	Author: SNC Lavalin Published: 2011	Arc flash and coordination study and electronic data files REPO TK 152.A7 2011-03 MRDF TK 152.A7 2011-03A
19	**McPhillips Pumping Gas Engine Driven Pump**	
	Author: Toromont Published: 1998	Shop Drawings TD 485.T676 1998
20	**The City of Winnipeg – Water and Waste Department Water Supply Hydraulics**	
	Author: AECOM Published: 2010	Operational Guidance Document
The following documents are available electronically online		
21	**The City of Winnipeg Water & Waste Department Electrical Design Guide** https://winnipeg.ca/waterandwaste/pdfs/dept/ElectricalDesignGuide.pdf	
22	**The City of Winnipeg Water & Waste Department Identification Standard** https://winnipeg.ca/waterandwaste/pdfs/dept/IdentificationStandard.pdf	
23	**The City of Winnipeg Water & Waste Department Drawing Standard** https://winnipeg.ca/waterandwaste/dept/cad_gis.stm	
24	**Deacon Water Treatment Program – Supply of Deacon Booster Pumps** https://www.winnipeg.ca/MatMgt/FolderContents.asp?FOLDER_NAME=571-2005&YEAR=2005	
25	**RDS SCADA SYSTEM UPGRADE, PLC REPLACEMENT, AND POWER RELIABILITY UPGRADES** https://www.winnipeg.ca/MatMgt/FolderContents.asp?FOLDER_NAME=805-2019&YEAR=2019	

APPENDIX D – HISTORICAL DRAWINGS

The following historical drawings are available electronically by request to the Project Manager after completion of a Non-Disclosure Agreement.

Drawing Number	Drawing Name/Title
Deacon Booster Pumping Station	
1-0601D-E0004-001	Electrical - Lower Level Plan – Layout Above 227.000m
1-0601D-E0005-001	Electrical - Upper Level Plan – Layout Above 230.800m
1-0601D-E0006-001	Electrical – Single Line Diagram
1-0601D-E0007-001	Electrical - Switchgear Replacement and Upgrade Sequence of Operations Sheet 1 of 3
1-0601D-E0007-002	Electrical - Switchgear Replacement and Upgrade Sequence of Operations Sheet 2 of 3
1-0601D-E0007-003	Electrical - Switchgear Replacement and Upgrade Sequence of Operations Sheet 3 of 3
1-0601D-E0008-001	Electrical - Switchgear Replacement and Upgrade Final Switchgear Arrangement
1-0601D-E0009-001	Electrical - Schedule and Schematic
1-0601D-E0010-001	Electrical - Control Diagram
1-0601D-M0001-001	Process Mechanical - Lower Level Plan Layout Above 227.000m
1-0601D-M0005-001	Process Mechanical - Branch I Section Sheet 1 of 4
1-0601D-M0005-002	Process Mechanical - Branch I Section Sheet 2 of 4
1-0601D-M0005-003	Process Mechanical - Branch I Section Sheet 3 of 4
1-0601D-M0005-004	Process Mechanical - Branch I Section Sheet 4 of 4
1-0601D-P0003-001	Process Branch I Booster Pumps Process and Instrumentation Diagram Sheet 1 of 3
1-0601D-P0003-002	Process Branch I Booster Pumps Process and Instrumentation Diagram Sheet 2 of 3
1-0601D-P0011-001	Branch I Discharge Process and Instrumentation Diagram
1-0601D-S0001-001	Structural - Lower Level Plan Layout Above 227.000m
1-0601D-S0002-001	Structural - Lower Level Plan Plans and Sections
1-0601D-S0003-001	Structural - Sections and Details
1-0601Y-C0010-001	Chlorine Line Relocation
1-0601D-A0058-001	Chlorine Rail Car Emergency Isolation System - Chlorine Railcar Shutoff Valves - Process & Instrumentation Diagram
1-0620D-A0059-001	Chlorine Rail Car Emergency Isolation System - Electrical, Instrument and Device Locations - Site Plan
1-0620D-A0060-001	Chlorine Rail Car Emergency Isolation System - Panel CP810 Details - Panel Layout
1-0620D-A0061-001	Chlorine Rail Car Emergency Isolation System - Panel CP800B Bill of Materials / Details - Panel Layout
1-0620D-A0062-001	Chlorine Rail Car Emergency Isolation System - Panel CP810 and CP800B - Control Schematic
1-0620D-A0063-001	Chlorine Rail Car Emergency Isolation System - Panel CP810 and CP800B - Control Wiring Diagram
1-0620D-A0064-001	Chlorine Rail Car Emergency Isolation System - DC-811-XSV Valve - Instrument Loop Diagram
1-0620D-A0065-001	Chlorine Rail Car Emergency Isolation System - DC-812-XSV Valve - Instrument Loop Diagram
1-0620D-A0066-001	Chlorine Rail Car Emergency Isolation System - DC-813-PSL Low Pressure Switch - Instrument Loop Diagram
1-0620D-A0067-001	Chlorine Rail Car Emergency Isolation System - Panel CP810 Bill of Materials - Panel Layout

Drawing Number	Drawing Name/Title
1-0620D-A0068-001	Chlorine Rail Car Emergency Isolation System - Junction Box JB810B - Control Wiring Diagram
1-0620D-A0069-001	Chlorine Rail Car Emergency Isolation System - PLC I/O - Instrument Loop Diagram
1-0620D-A0076-001	Chlorine Evaporator #3 Loop Wiring Diagram
1-0620D-A0077-001	Chlorinator #3 Loop Wiring Diagram
1-0620D-B0001-001	Building Upgrades and Maintenance - Demolition Plan
1-0620D-B0002-001	Building Upgrades and Maintenance - New Roof Plan and Details
1-0620D-B0003-001	Building Upgrades and Maintenance - Miscellaneous Details
1-0620D-E0008-001	Station Arc Flash Study - Electrical Single Line Diagram - Legend and Details
1-0620D-E0009-001	Arc Flash Study Electrical Single Line Diagram 4160v Switchgear SGR-D1 AND SGR-D2
1-0620D-E0010-001	Arc Flash Study - Electrical Single Line Diagram Non-Essential MCC MCC-01
1-0620D-E0010-002	Arc Flash Study Electrical Single Line Diagram Non- Essential MCC MCC-D1 Sheet 2 of 2
1-0620D-E0011-001	Arc Flash Study Electrical Single Line Diagram Essential MCC MCC-D2
1-0620D-E0013-001	Arc Flash Study Electrical Single Line Diagram 600V Distribution Panel DP-D3
1-0620D-E0014-001	Arc Flash Study Electrical Single Line Diagram
1-0620D-M0001-001	Chlorine Rail Car Emergency Isolation System - Railcar Connection - Piping Isometric
1-0620D-M0002-001	Chlorine Rail Car Emergency Isolation System - Nitrogen Supply - Piping Diagram
D-1986	Process & Instrumentation Diagram Chlorination System
D-1897	Process & Instrumentation Diagram Chlorination System
D-1900	Instrumentation Location Layout & Elec Power Layout Upper Level Pump Sta Control Rm & Chlorine Room
D-2854	Deacon Booster Pumping Station - MCP Cl_2 Tank Car Empty Switch
D-2855	MCP Chlorine Evaporator # 1
D-2856	MCP Chlorine Evaporator # 2
D-2857	MCP Cl_2 Mass Flow
D-2858	MCP Chlorinator # 1
D-2860	MCP Cl_2 Room Temperature Switch
D-2866	MCP Cl_2 PP # 1 Control
D-2867	MCP Cl_2 PP # 2 Control
D-2912	MCP Cl_2 MASS FLOW #2
D-5606	SCADA System - Main Control Panel - Layout
D-5607	SCADA System - Main Control Panel - Bill of Materials
D-5608	SCADA System - PLC Wiring Schematic - Power Distribution MCP - Lines 1000-1149
D-5609	SCADA System - PLC Wiring Schematic - Power Distribution MCP - Lines 1150-1299
D-5610	SCADA System - PLC Wiring Schematic - Power Distribution MCP - Lines 1300-1449
D-5611	SCADA System - PLC Wiring Schematic - Power Distribution MCP - Lines 1450-1599
D-5612	SCADA System - PLC Wiring Schematic - Power Distribution MCP - Lines 1600-1749
D-5613	SCADA System - PLC Wiring Schematic - Power Distribution MCP - Lines 1750-1899
D-5614	SCADA System - PLC Wiring Schematic - Power Distribution MCP - Lines 1900-2049

Drawing Number	Drawing Name/Title
D-5615	SCADA System - PLC Wiring Schematic - Power Distribution MCP - Lines 2050-2199
D-5616	SCADA System - PLC Wiring Schematic - Power Distribution MCP - Lines 2200-2349
D-5617	SCADA System - PLC Wiring Schematic - Power Distribution MCP - Lines 2350-2499
DBP-5	Architectural Part Plan Above Elev 236.500 M
DBP-6	Architectural Acoustic Ceiling Plan
DBP-9	Architectural Building Cross Sections
DBP-11	Architectural Sections and Details
DBP-12	Architectural Details
DBP-18	Structural Plan Above Elev 236.500 M and Roof Plans
DBP-21	Structural Plan Above Elev 236.500 M
DBP-22	Structural Sections I
DBP-24	Structural Sections III
DBP-25	Structural Plans & Details Chlorine Trench & Electrical Duct Bank
DBP-27	Structural Miscellaneous Details
DBP-30	Mechanical Plans Above Elev 236.500 M & Sections
DBP-36	Mechanical Schematics-Sheet II & Liquid Chlorine Unloading Station
DBP-41	Mech Plumb Drain & Ventilation Plan Above Elev 232.450 M
DBP-42	Mech Plumb Drain & Ventilation Plan Above Elev 236.500 M
DBP-44	Mechanical Plumbing Drainage & Ventilation Sections
DBP-45	Mechanical Plumbing Drainage & Ventilating Sections
DBP-54	Electrical Plan Above Elev 236.500 M
MacLean Regional Pumping Station	
1-0630A-P0001-001	Process & Instrumentation Diagram - Legend & Details - Sheet 1 of 3
1-0630A-P0001-002	Process & Instrumentation Diagram - Legend & Details - Sheet 2 of 3
1-0630A-P0001-003	Process & Instrumentation Diagram - Legend & Details - Sheet 3 of 3
1-0630M-A0028-001	P26 Engine Replacement - Process and Instrumentation Diagrams - Symbols Legend Sheet 1 of 3
1-0630M-A0028-002	P26 Engine Replacement - Process and Instrumentation Diagrams - Symbols Legend Sheet 2 of 3
1-0630M-A0028-003	P26 Engine Replacement - Process and Instrumentation Diagrams - Symbols Legend Sheet 3 of 3
1-0630M-A0029-001	P26 Engine Replacement - Instrumentation - Loop Diagrams
1-0630M-E0001-001	Maclean Water Pumping Station - Electrical Single Line Diagram - Legend & Details
1-0630M-E0011-001	P26 Engine Replacement - Electrical – New Construction - Pump/Engine Level Floor Plan
1-0630M-E0012-001	Electrical Equipment Plan, Electrical Room
1-0630M-E0021-001	Electrical Single Line Diagram - Miscellaneous Distribution
1-0630M-E0022-001	Electrical Single Line Diagram - Overview
1-0630M-E0023-001	Electrical Single Line Diagram, MCC-M710
1-0630M-E0024-001	Electrical Single Line Diagram, DP-M720
1-0630M-E0025-001	Electrical Single Line Diagram, MCC-M730E Essential MCC
1-0630M-E0026-001	MCC Elevation and Details, MCC-M710
1-0630M-E0027-001	MCC Elevation and Details, MCC-M730E
1-0630M-E0028-001	MCC Schedules, MCC-M710 and MCC-M730E
1-0630M-E0029-001	Panel Schedule and Details, DP-M720
1-0630M-E0030-001	Electrical Equipment Plan, Pump Level
1-0630M-E0034-001	Cable Tray Layout, Mezzanine Level - Sheet 1 of 3
1-0630M-E0034-002	Cable Tray Layout, Mezzanine Level - Sheet 2 of 3
1-0630M-E0034-003	Cable Tray Layout, Mezzanine Level - Sheet 3 of 3
1-0630M-E0035-001	Cable Tray Layout, Electrical Room

Drawing Number	Drawing Name/Title
1-0630M-E0040-001	Conduit Riser Diagram
1-0630M-E0041-001	Grounding Plan, Mezzanine Level - Sheet 1 of 2
1-0630M-E0041-002	Grounding Plan, Mezzanine Level - Sheet 2 of 2
1-0630M-M0001-001	P26 Engine Replacement - Mechanical – Legend and General Notes
1-0630M-M0004-001	P26 Engine Replacement - Mechanical – New Construction - Pump/Engine – Plan and Section
1-0630M-M0005-001	P26 Engine Replacement - Mechanical – New Construction - Pump/Engine - Piping and Support Details
1-0630M-M0008-001	P26 Engine Replacement - Mechanical – Auxiliary Cooling Circuit Expansion Tank - Schematic Detail and Section
1-0630M-M0009-001	P26 Engine Replacement - Mechanical – Main Cooling Circuit Expansion Tank - Schematic Detail and Section
1-0630M-M0010-001	P22 Engine Replacement - Mechanical - Legend And General Notes
1-0630M-M0012-001	P22 Engine Replacement - Mechanical - Plan Section and Detail
1-0630M-M0013-001	P22 Engine Replacement - Mechanical - Auxiliary Cooling Circuit Expansion Tank Schematic, Detail and Section
1-0630M-M0014-001	P22 Engine Replacement - Mechanical - Main Cooling Circuit Expansion Tank Schematic, Detail and Section
1-0630M-P0004-001	Process & Instrumentation Diagram - Pump P-M022
1-0630M-P0008-001	Process & Instrumentation Diagram - Pump P-M026
1-0630M-S0001-001	P26 Engine Replacement Concrete Base – Plan and Section
B-570	Yard Piping
D-1919	Instrumentation Location Layout & Elec Power Layout Main & Upper Levels Pump Sta
D-2550	LCP22 Elec Pump # 22 Discharge Valve Control / Pos Status
D-2251	LCP22 Gas Pump # 22 Selector Switch
D-2252	LCP22 Gas Pump # 22 Selector Switch
D-2253	LCP22 Gas Pump # 22 Selector Switch
D-2254	LCP22 Gas Pump # 22 Selector Switch
D-2555	LCP22 Gas Pump # 22 Digital Speed Control
D-2556	LCP22 Gas Pump # 22 Digital Speed Control
D-2557	LCP22 Gas Pump # 22 Elasped Time Meter
D-2558	LCP22 Gas Pump # 22 Temp / Vib Monitor
D-2559	LCP22 Gas Pump # 22 Temp / Vib Monitor
D-2560	LCP22 Gas Pump # 22 Temp / Vib Monitor
D-2561	LCP22 Gas Pump # 22 Temp / Vib Monitor
D-2562	LCP22 Gas Pump # 22 Temp / Vib Monitor
D-2563	LCP22 Gas Pump # 22 Temp / Vib Monitor
D-2564	LCP22 Gas Pump # 22 Speed Monit Loop
D-2565	LCP22 Gas Pump # 22 Speed Monit Loop
D-2566	LCP22 Gas Pump # 22 Engine Clutch Control
D-2567	LCP22 Gas Pump # 22 PLC / Fail Reset
D-2568	LCP22 Gas Pump # 22 Lamptest
D-2620	LCP26 Elec Pump # 26 Discharge Valve Control / Pos Status
D-2621	LCP26 Gas Pump # 26 Selector Switch
D-2622	LCP26 Gas Pump # 26 Selector Switch
D-2623	LCP26 Gas Pump # 26 Selector Switch
D-2624	LCP26 Gas Pump # 26 Selector Switch
D-2625	LCP26 Gas Pump # 26 Digital Speed Control
D-2626	LCP26 Gas Pump # 26 Digital Speed Control
D-2627	LCP26 Gas Pump # 26 Elasped Time Meter
D-2628	LCP26 Gas Pump # 26 Temp / Vib Monitor
D-2629	LCP26 Gas Pump # 26 Temp / Vib Monitor
D-2630	LCP26 Gas Pump # 26 Temp / Vib Monitor

Drawing Number	Drawing Name/Title
D-2631	LCP26 Gas Pump # 26 Temp / Vib Monitor
D-2632	LCP26 Gas Pump # 26 Temp / Vib Monitor
D-2633	LCP26 Gas Pump # 26 Temp / Vib Monitor
D-2634	LCP26 Gas Pump # 26 Speed Monit Loop
D-2635	LCP26 Gas Pump # 26 Speed Monit Loop
D-2636	LCP26 Gas Pump # 26 Engine Clutch Control
D-2637	LCP26 Gas Pump # 26 PLC / Fail Reset
D-2638	LCP26 Gas Pump # 26 Lamptest
1-0630P-A0023-001	Local Control Panel – LCP-22 - Demolition
1-0630P-A0024-001	Local Control Panel – LPC-22 – Panel Layout
1-0630P-A0025-001	Local Control Panel – LPC-22 – Power Distribution
1-0630P-A0026-001	PLC-M022 – Rack Layout
1-0630P-A0027-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Rack Layout
1-0630P-A0028-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Power Supply Wiring Diagram
1-0630P-A0029-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Slot 1 Wiring Diagram
1-0630P-A0030-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Slot 2 Wiring Diagram
1-0630P-A0031-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Slot 3 Wiring Diagram
1-0630P-A0032-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Slot 4 Wiring Diagram
1-0630P-A0033-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Slot 5 Wiring Diagram
1-0630P-A0034-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Relay Card Wiring Diagram
1-0630P-A0067-001	Local Control Panel – LCP-22 - Demolition
1-0630P-A0068-001	Local Control Panel – LPC-22 – Panel Layout
1-0630P-A0069-001	Local Control Panel – LPC-22 – Power Distribution
1-0630P-A0070-001	PLC-M022 – Rack Layout
1-0630P-A0071-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Rack Layout
1-0630P-A0072-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Power Supply Wiring Diagram
1-0630P-A0073-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Slot 1 Wiring Diagram
1-0630P-A0074-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Slot 2 Wiring Diagram
1-0630P-A0075-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Slot 3 Wiring Diagram
1-0630P-A0076-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Slot 4 Wiring Diagram
1-0630P-A0077-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Slot 5 Wiring Diagram
1-0630P-A0078-001	Pump and Motor Condition Monitoring Unit - PMCM-M022 - Relay Card Wiring Diagram
1-0630P-E0007-001	Floor Plan - Electrical Room
1-0630P-E0008-001	Floor Plan - Mezzanine Level
1-0630P-E0008-002	Floor Plan - Mezzanine Level
1-0630P-E0009-001	Floor Plan - Pump Level
1-0640P-E0010-001	Elevation and Cross-Section
MAC-5-1	SCADA System - Pumps 22 & 26 Local Control - Panel Layout

Drawing Number	Drawing Name/Title
MAC-5-2	SCADA System - Pumps 22 & 26 Local Control Panel - Bill of Materials
MAC-5-3	SCADA System - PLC Wiring Schematic - Power Distribution LCP22 - Lines 1000-1149
MAC-5-4	SCADA System - PLC Wiring Schematic - LCP22 Rack 1 - Lines 1150-1299
MAC-5-5	SCADA System - PLC Wiring Schematic - LCP22 Rack 2 - Lines 1300-1449
MAC-5-6	SCADA System - PLC Wiring Schematic - LCP22 Rack 3 - Lines 1450-1599
MAC-5-7	SCADA System - PLC Wiring Schematic - LCP22 Rack 4 - Lines 1600-1749
MAC-5-8	SCADA System - Temperature/Vibration Monitor Schematics LCP-22 - Lines 1750-1899
MAC-5-9	SCADA System - Temperature/Vibration Monitor Schematics LCP-22 - Lines 1900-2049
MAC-5-10	SCADA System - Miscellaneous Schematics - Lines 2050-2199
MAC-5-11	SCADA System - PLC Wiring Schematic - Power Distribution LCP26 - Lines 2200-2349
MAC-5-12	SCADA System - PLC Wiring Schematic - LCP26 Rack 1 - Lines 2350-2499
MAC-5-13	SCADA System - PLC Wiring Schematic - LCP26 Rack 2 - Lines 2500-2649
MAC-5-14	SCADA System - PLC Wiring Schematic - LCP26 Rack 3 - Lines 2650-2799
MAC-5-15	SCADA System - PLC Wiring Schematic - LCP26 Rack 4 - Lines 2800-2949
MAC-5-16	SCADA System - Temperature/Vibration Monitor Schematics LCP-26 - Lines 2950-3099
MAC-5-17	SCADA System - Temperature/Vibration Monitor Schematics LCP-26 - Lines 3100-3249
MAC-5-18	SCADA System - Miscellaneous Schematics - Lines 3250-3399
B-570	Yard Piping
ME-2	Valve Location Drawing No. 1
ME-3	Valve Location Drawing No. 2
ME-7	Reservoir Schematic Valve Layout
ME-7-A	Reservoir Schematic Valve Layout
ME-8	Site & Location Plan
ME-9	Structural - Plan Above Elevation 740.00 Sheet I
ME-10	Structural - Plan Above Elevation 740.00 Sheet II
ME-11	Structural - Plan Above Elevation 750.00 Sheet I
ME-12	Structural - Plan Above Elevation 750.00 Sheet II
ME-13	Structural - Plan Above Elevation 762.00 Sheet I
ME-14	Structural - Plan Above Elevation 762.00 Sheet II
ME-15	Structural - Sections Sheet I
ME-16	Structural - Sections Sheet II
ME-17	Structural - Structural Steel
ME-18	Superstructure – Elevations
ME-19	Superstructure - Plans Above Elevations 740.00 and 750.00
ME-20	Superstructure Plan Above Elevation 762.00 and Roof Plan
ME-21	Superstructure - Wall Sections
ME-22	Superstructure Sections and Details
ME-23	Superstructure Schedules and Details
ME-24	Mechanical - Plan Above Elevations 730.00 740.00 & 750.00
ME-25	Mechanical - Plan Above Elevation 740.00 and Section

Drawing Number	Drawing Name/Title
ME-26	Mechanical - Sections
ME-30	Pumping Station Mechanical - Plumbing
ME-32	Heating and Ventilation Plans Above Elevations 740.00 and 750.00
ME-33	Heating and Ventilation Plan Above Elevation 762.00 and Sections
ME-46	Yard Piping Plans and Profile
ME-49	General Arrangement and Layout Control
ME-50	Site Grading Plan
ME-57	Yard Piping - Plan and Profiles
McPhillips Pumping Station	
1-0640A-P0001-001	Process & Instrumentation Diagram - Legend & Details - Sheet 1 of 3
1-0640A-P0001-002	Process & Instrumentation Diagram - Legend & Details - Sheet 2 of 3
1-0640A-P0001-003	Process & Instrumentation Diagram - Legend & Details - Sheet 3 of 3
1-0640M-E0023-001	Cable Tray Layout, Lower Pump Room
1-0640M-E0024-001	Cable Tray Section & Details, Lower Pump Room
1-0640M-P0002-001	Process & Instrumentation Diagram - Pump P-M001
1-0640M-P0004-001	Process & Instrumentation Diagram - Pump P-M003
1-0640M-P0006-001	Process & Instrumentation Diagram - Pump P-M005
B-569	Yard Piping
B-605	Pumping Station And Reservoir Piping
CP1	Pump 3 Local Control Panel Layout
CP2	Pump 3 LCP Bill Of Materials
CP3	LCP3 - PLC & Power Distribution
CP4	LCP3 Rack 1 - PLC Wiring Schematic
CP5	LCP3 - Rack 2 - PLC Wiring Schematic
CP6	LCP3 Rack 3 - PLC Wiring Schematic
CP7	LCP3 Rack 4 - PLC Wiring Schematic
CP8	LCP 3 Temperature/Vibration Monitor
CP9	LCP 3 Temperature/Vibration Monitor
D-1625	Site Plan and Feedermain Connection Details At McPhillips Pumping Station
D-2265	LCP1 Pump # 1 Elapsed Time Meter
D-2266	LCP1 Pump # 1 Discharge Valve Control Pos Status
D-2267	LCP1 Gas Pump # 1 Selector Switch
D-2268	LCP1 Gas Pump # 1 Engine Drive
D-2269	LCP1 Gas Pump # 1 Engine Drive
D-2270	LCP1 Gas Pump # 1 Engine Drive
D-2271	LCP1 Gas Pump # 1 Digital Speed Control
D-2272	LCP1 Gas Pump # 1 Temp / Vib Monitor
D-2273	LCP1 Gas Pump # 1 Temp / Vib Monitor
D-2274	LCP1 Gas Pump # 1 Temp / Vib Monitor
D-2275	LCP1 Gas Pump # 1 Temp / Vib Monitor
D-2276	LCP1 Gas Pump # 1 Temp / Vib Monitor
D-2277	LCP1 Gas Pump # 1 Temp / Vib Monitor
D-2278	LCP 1 Gas Pump # 1 Speed Monitor Loop
D-2279	LCP 1 Gas Pump # 1 Speed Monitor Loop
D-2280	LCP1 Gas Pump # 1 Engine Clutch Control
D-2281	LCP1 Gas Pump # 1 Plc Fail / Reset
D-2282	LCP1 Gas Pump # 1 Lamptest
D-2283	LCP1 Gas Pump # 1 Alarm Lights
D-2310	LCP3 Pump # 3 Elapsed Time Meter
D-2311	LCP3 Pump # 3 Discharge Valve Control Pos Status
D-2312	LCP3 Gas Pump # 3 Selector Switch
D-2313	LCP3 Gas Pump # 3 Engine Drive

Drawing Number	Drawing Name/Title
D-2314	LCP3 Gas Pump # 3 Engine Drive
D-2315	LCP3 Gas Pump # 3 Engine Drive
D-2316	LCP3 Gas Pump # 3 Digital Speed Control
D-2317	LCP3 Gas Pump # 3 Temp / Vib Monitor
D-2318	LCP3 Gas Pump # 3 Temp / Vib Monitor
D-2319	LCP3 Gas Pump # 3 Temp / Vib Monitor
D-2320	LCP3 Gas Pump # 3 Temp / Vib Monitor
D-2321	LCP3 Gas Pump # 3 Temp / Vib Monitor
D-2322	LCP3 Gas Pump # 3 Temp / Vib Monitor
D-2323	LCP3 Gas Pump # 3 Speed Monitor Loop
D-2324	LCP3 Gas Pump # 3 Speed Monitor Loop
D-2325	LCP3 Gas Pump # 3 Engine Clutch Control
D-2326	LCP3 Gas Pump # 3 Plc Fail / Reset
D-2327	LCP3 Gas Pump # 3 Lamptest
D-2328	LCP3 Gas Pump # 3 Alarm Lights
D-2365	LCP5 Pump # 5 Elapsed Time Meter
D-2366	LCP5 Pump # 5 Discharge Valve Control Pos Status
D-2367	LCP5 Gas Pump # 5 Selector Switch
D-2368	LCP5 Gas Pump # 5 Engine Drive
D-2369	LCP5 Gas Pump # 5 Engine Drive
D-2370	LCP5 Gas Pump # 5 Engine Drive
D-2371	LCP5 Gas Pump # 5 Digital Speed Control
D-2372	LCP5 Gas Pump # 5 Temp / Vib Monitor
D-2373	LCP5 Gas Pump # 5 Temp / Vib Monitor
D-2374	LCP5 Gas Pump # 5 Temp / Vib Monitor
D-2375	LCP5 Gas Pump # 5 Temp / Vib Monitor
D-2376	LCP5 Gas Pump # 5 Temp / Vib Monitor
D-2377	LCP5 Gas Pump # 5 Temp / Vib Monitor
D-2378	LCP5 Gas Pump # 5 Speed Monitor Loop
D-2379	LCP5 Gas Pump # 5 Speed Monitor Loop
D-2380	LCP5 Gas Pump # 5 Engine Clutch Control
D-2381	LCP5 Gas Pump # 5 Plc Fail / Reset
D-2382	LCP5 Gas Pump # 5 Lamptest
D-2383	LCP5 Gas Pump # 5 Alarm Lights
D-5397	New Gas Engine Pump No3 General Arrangement Plan Gas Exhaust and Cooling Connections
D-5398	New Gas Engine Pump No.3 Mechanical Sections, Details and Schematics
D-5400	Instrumentation Symbols and Identification
D-5411	Instrumentation Location Layout and Electrical Power Layout
D-6279	Site Plan of McPhillips Pumping Station
McP-230	Pumphouse Piping
McP-235	Pumphouse Piping
McP-25	Mechanical - Sections
McP-64	Contract “C” - Water Pumping Equipment - Sections
McP-65	Contract "C" - Water Pumping Equipment - Station Layout
McP-66	Contract "D" Valves Station Layout
McP-67	Contract "D" Valves Sections
McPH-5-1	SCADA System - Pumps 1 & 5 Local Control - Panel Layout
McPH-5-2	SCADA System - Local Control Panels LCP 1,5 – Bill of Materials
McPH-5-3	SCADA System - PLC Wiring Schematic - Power Distribution LCP1 - Lines 1000-1149
McPH-5-4	SCADA System - PLC Wiring Schematic - LCP1 Rack 1 - Lines 1150-1299

Drawing Number	Drawing Name/Title
McPH-5-5	SCADA System - PLC Wiring Schematic - LCP1 Rack 2 - Lines 1300-1449
McPH-5-6	SCADA System - PLC Wiring Schematic - LCP1 Rack 3 - Lines 1450-1599
McPH-5-7	SCADA System - PLC Wiring Schematic - LCP1 Rack 4 - Lines 1600-1749
McPH-5-8	SCADA System - Temperature/Vibration Monitor Schematics LCP-1 - Lines 1750-1899
McPH-5-9	SCADA System - Temperature/Vibration Monitor Schematics LCP-1 - Lines 1900-2049
McPH-5-10	SCADA System - Miscellaneous Schematics - Lines 2050-2199
McPH-5-11	SCADA System - PLC Wiring Schematic - Power Distribution LCP5 - Lines 2200-2349
McPH-5-12	SCADA System - PLC Wiring Schematic - LCP5 Rack 1 - Lines 2350-2499
McPH-5-13	SCADA System - PLC Wiring Schematic - LCP5 Rack 2 - Lines 2500-2649
McPH-5-14	SCADA System - PLC Wiring Schematic - LCP5 Rack 3 - Lines 2650-2799
McPH-5-15	SCADA System - PLC Wiring Schematic - LCP5 Rack 4 - Lines 2800-2949
McPH-5-16	SCADA System - Temperature/Vibration Monitor Schematics LCP-5 - Lines 2950-3099
McPH-5-17	SCADA System - Temperature/Vibration Monitor Schematics LCP-5 - Lines 3100-3249
McPH-5-18	SCADA System - Miscellaneous Schematics - Lines 3250-3399
McPH-5-19	SCADA System - Pump 3 Local Control Panel Layout
McPH-5-20	Pump #3 LCP Bill Of Materials
McPH-5-21	LCP3- PLC & Power Distribution
McPH-5-22	LCP3 Rack 1- PLC Wiring Schematic
McPH-5-23	LCP3 Rack 2- PLC Wiring Schematic
McPH-5-24	LCP3 Rack 3- PLC Wiring Schematic
McPH-5-25	LCP3 Rack 4- PLC Wiring Schematic
McPH-5-26	LCP3 Temperature/Vibration Monitor P.1 of 2
McPH-5-27	LCP3 Temperature/Vibration Monitor P.2 of 2
McPH-7-2	SCADA System - Gas Pump Local Control Panel
Q-McP-146	Waukesha L-5790-G General Arrangement
McP-1	Contract "A" Architectural Plans Above Elev 749.0 & 764.5
McP-2	Contract "A" Architectural Elevations
McP-23	Contract "A" Mechanical - Plan Above Elevation 749.0
McP-25	Contract “A” Mechanical Sections
McP-37	Contract "A" Structural-Plan Above Elevation 749.0
McP-38	Contract "A" Structural-Plan Above Elevation 764.5
McP-39	Contract "A" Structural-Sections Sheet 1
McP-40	Contract "A" Structural-Sections Sheet 2
McP-41	Contract "A" Structural-Beam Details
McP-42	Contract "A" Structural-Structural Steel
Hurst Pumping Station	
1-0650A-C0001-001	Hurst Pumping Station – Municipal Site Plan
1-0650A-C0002-001	Hurst Pumping Station – Grading Plan
1-0650A-C0003-001	Hurst Pumping Station – Sensitive Infrastructure Protection Plan
1-0650A-P0001-001	Hurst Pumping Station - Process & Instrumentation Diagram - Legend & Details - Sheet 1 of 3

Drawing Number	Drawing Name/Title
1-0650A-P0001-002	Hurst Pumping Station - Process & Instrumentation Diagram - Legend & Details - Sheet 2 of 3
1-0650A-P0001-003	Hurst Pumping Station - Process & Instrumentation Diagram - Legend & Details - Sheet 3 of 3
1-0650M-E0001-001	Hurst Pumping Station - Electrical Single Line Diagram - Legend & Details
1-0650M-E0003-001	Hurst Pumping Station – Electrical Single Line Diagram – 600V Distribution
1-0650M-E0013-001	Hurst Pumping Station – 4160V Switchgear & 600V CDP/MCC
1-0650M-E0014-001	Hurst Pumping Station – Electrical Equipment Plan Electrical Room
1-0650M-E0015-001	Hurst Pumping Station – Single Line Diagram PNL-AA and Chiller
1-0650M-E0016-001	Hurst Pumping Station – Single Line Diagram PNL-BB
1-0650M-E0018-001	Hurst Pumping Station – Single Line Diagram PNL-EE
1-0650M-P0021-001	Hurst Pumping Station – Process & Instrumentation Diagram Chiller Water System
1-0650M-M0005-001	Hurst Pumping Station - Mechanical Pump Station Roof HVAC Plan - New
D-2665	Hurst Pumping Station – MCP Station High Temperature Switch (Loop Drawing)
D-2666	Hurst Pumping Station - MCP Station Low Temperature Switch (Loop Drawing)
D-2667	Hurst Pumping Station - MCP HVAC General Alarm Switch (Loop Diagram)
D-2676	Hurst Pumping Station - MCP Spare (Loop Diagram)
D-2683	Hurst Pumping Station - MCP Spare (Loop Diagram)
HURST-21	Hurst Pumping Station – Pumphouse HVAC Flow Diagram
HURST-25	Contract 4 – Expansion to W.D. Hurst Pumping Station Site Plan
HURST-27	Contract 4 – Expansion to W.D. Hurst Pumping Station Main Floor Plan & Details
HURST-28	Contract 4 – Expansion to W.D. Hurst Pumping Station Building Sections, Wall Sections
HURST-29	Contract 4 – Expansion to W.D. Hurst Pumping Station Building Elevation & Details
HURST-30	Contract 4 – Expansion to W.D. Hurst Pumping Station Foundation Plans Main Floor and Roof Framing Plans
HURST-31	Contract 4 – Expansion to W.D. Hurst Pumping Station Sections and Details
HURST-35	Contract 4 – Expansion to W.D. Hurst Pumping Station Site Plan & Duct Bank Details
HURST-36	Contract 4 – Expansion to W.D. Hurst Pumping Station Building Extensions Power and Lighting
HURST-37	Contract 4 – Expansion to W.D. Hurst Pumping Station Building Extension Conduit Details
HURST-72	Hurst Pumping Station – Pumphouse HVAC Mechanical
WH5622-02	Hurst Pumping Station Large Scale Site Plan
WH5622-03	Hurst Pumping Station – Floor Plans & Schedules
WH5622-04	Hurst Pumping Station – Building Elevations
WH5622-05	Hurst Pumping Station – Building Sections
WH5622-06	Hurst Pumping Station – Wall Sections
WH5622-15	Hurst Pumping Station – Upper Level Plumbing & Ventilation
WH5622-18	Hurst Pumping Station – Site Plan Showing Pipe Layout

APPENDIX E – NON-DISCLOSURE AGREEMENT

To register, please complete and return this Non-Disclosure Agreement by email

TO: Jeff Brooks, C.E.T.
Project Manager
jeffbrooks@winnipeg.ca
Fax: (204) 986-2045

REFERENCE: Request for Proposal No. ^-2021 for Professional Consulting Services for Cooling Upgrades - Water Pumping Stations (the "RFP")

In consideration of receiving Confidential Information from the City of Winnipeg and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, _____(insert name of legal name of counterparty) (the "Confidant") agrees as follows:

1. Definitions: In this Agreement the following terms shall have the following meanings:

a) "Agreement" means this agreement.
b) "Confidant" means the Person named as such above.
c) "Confidential Information" means any and all information, regardless of form, format or medium (including without limitation visual or oral information), of, related to, concerning, or resulting from, the City, the RFP and/or the Permitted Use, which comes into the possession or knowledge of the Confidant, including, without limitation, the RFP, documents, business information, know how, data, trade secrets, processes, designs, communications, materials, drawings, diagrams, computer programs, concepts, and any and all copies, reproductions, modifications, and derivative works.
d) "Effective Date" is the day and date last below written.
e) "City" means The City of Winnipeg.
f) "Permitted Use" means private evaluation by the Confidant solely for the purpose of preparing a submission(s) to City in response to the RFP, and for no other purpose whatsoever.
g) "Person" shall be broadly interpreted to include, without limitation, any corporation, partnership, other entity, or individual.
h) "RFP" has the meaning given above.
i) "Third Party" means any Person other than City or Confidant.

2. Access/Use of Confidential Information: Subject to the terms and conditions of this Agreement, Confidant may use the Confidential Information only for the Permitted Use and for no other purpose whatsoever. Confidant acknowledges and agrees that City reserves the full independent right to modify the scope and content of Confidential Information available for access and/or use hereunder at any time and without prior notice.

3. Restrictions: Confidant agrees that:

1. Confidential Information shall be kept in the strictest confidence without limitation of time, and shall not be disclosed to any Third Party;
2. Confidant shall restrict access to Confidential Information only to its employees with a need to know to carry out the Permitted Use, and prior to disclosing same, each such employee shall be made aware of the terms and conditions of this Agreement; and
3. Confidant shall cause all of its applicable employees to observe the terms of this Agreement, and shall be responsible for any breach of the terms of this Agreement by it or any such employee.

4. Return of Confidential Information: The Confidant shall immediately on notice at any time from City return to City, or destroy, any and all Confidential Information in accordance with City's direction.

5. Continuing Obligations and Remedies: The obligations of Confidant under this Agreement shall not terminate but shall continue without limitation of time. Confidant acknowledges and agrees that a breach of any term or condition of this Agreement shall cause irreparable harm to City which cannot be adequately compensated for in damages, and accordingly Confidant agrees that City shall be entitled, in addition to any other remedies available to it, to interlocutory and permanent injunction relief to restrain any anticipated, present or continuing breach of this Agreement.

6. No License Granted: Confidant acknowledges and agrees that all rights in and to Confidential Information are and shall remain the sole property of City, and Confidant agrees that it shall not contest or challenge any of City's rights in or to any Confidential Information. Nothing in this Agreement obligates, or shall be deemed to obligate, City to provide, disclose, or deliver any Confidential Information.

7. Enurement: This Agreement shall be binding and shall enure to the benefit of the parties hereto, and their respective legal representatives, successors and permitted assigns.

8. Governing Law and Interpretation: This Agreement shall be subject to, interpreted, performed and enforced in accordance with the laws of Manitoba and the applicable laws of Canada without regard to Manitoba or Federal Canadian law governing conflicts of law, even if one or more of the parties to this Agreement is resident of or domiciled in any other province or country. Section headings in this Agreement are for the convenience of the parties only, and shall not affect the interpretation of this Agreement.

9. Severability: If any provision in this Agreement is illegal, invalid or unenforceable at law, it shall be deemed to be severed from this Agreement and the remaining provisions shall continue in full force and effect. The parties agree that they shall endeavor to replace any such severed provision with a new provision which achieves substantially the same practical effect and which is valid and enforceable.

10. No Waiver: No waiver of any provision of this Agreement, or a breach thereof, shall be effective unless it is in writing and signed by the party waiving the provision or the breach thereof. No waiver of a breach of this Agreement, whether express or implied, shall constitute a waiver of a subsequent breach thereof.

11. Amendments: No amendment or change or modification of this Agreement shall be valid unless it is in writing and signed by both parties.

12. Assignment: Confidant shall not assign this Agreement without first having obtained the prior written consent of City. No assignment of this Agreement shall operate so as to relieve Confidant from any obligation of this Agreement.

13. No Authority: This Agreement shall not create, nor shall it be deemed to create, the relationship of employer and employee, principal and agent, partnership, or joint venture, between City and Confidant. Confidant has no authority whatsoever to make any representation in respect of, enter any commitment on behalf of, or incur any liability for or on behalf of, City, or to bind or purport to bind City to any Third Party in any way whatsoever.

14. Further Acts and Assurances: Each of the parties shall, from time to time, do all acts and things and execute from time to time all such further documents and assurances as may be necessary to carry out and give effect to the terms and conditions of this Agreement.

15. Opportunity to Negotiate: Both parties have had the opportunity to negotiate, review and comment upon this Agreement, and obtain independent legal advice with respect to the content, meaning, and legal effect of this Agreement.

18. Fax Execution: This Agreement may be executed in any number of counterparts, including counterparts signed by fax, each of which shall be deemed an original and all of which together shall constitute one in the same instrument. A photocopied and/or fax copy of this Agreement bearing the signature of each party, in a single document or counterparts thereof as provided herein, shall be deemed an original execution version of this Agreement.

IN WITNESS WHEREOF, an authorized representative of the Confidant has executed and delivered this Agreement, as of the ____ (day) day of _____ (month), 2021 (the "Effective Date").

Authorized Signature _____

Print Name: _____

Title: _____

Confidant Contact:

Company Name: _____

Contact Name: _____

Title: _____

Telephone: _____ Fax: _____

Email: _____

APPENDIX F – PROCESS AND INSTRUMENTATION DIAGRAM REQUIREMENTS

A) SCOPE

a. This appendix describes the requirements for Process and Instrumentation Diagrams (P&IDs) format and content.

b. This appendix covers the generation of new P&IDs and does not apply to the revision of existing P&IDs. This appendix also applies to &IDs provided by packaged equipment vendors and contractors.

c. The requirements provided in this appendix provide a balance between showing all data on P&IDs and making P&IDs legible and easy to read. While this appendix is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this appendix. Determinations concerning fitness for purpose and particular matters or application of the appendix to particular project or engineering situations should not be made solely on information contained in these materials.

B) APPLICATION

a. Existing facilities do not necessarily comply with this appendix. The expectations regarding application of this appendix to existing facilities must be decided on a case-by-case basis in consultation with the Project Manager, however general guidelines for application are presented as follows:

1.1.1 All new facilities must comply completely.

1.1.2 All major upgrades to a facility, or a larger facility's process area, must completely comply. Any existing instruments within the area being upgraded should be re-identified.

1.1.3 All minor upgrades should utilize this appendix as far as practical, however in some cases compromises with the existing P&IDs may be required.

C) REFERENCES

a. City of Winnipeg Water & Waste Department (W&W)

1.1.4 Water and Waste Department Electrical Design Guide

1.1.5 Water and Waste Department Identification Standard

b. The Instrumentation, Systems, and Automation Society (ISA)

1.1.6 ISA 5.1 – Instrumentation Symbols and Identification

1.1.7 ISA 5.2 – Binary Logic Diagrams for Process Operations

1.1.8 ISA 5.3 – Graphic Symbols for Distributed Control / Shared Display Instrumentation, Logic and Computer Systems

1.1.9 ISA 84.01 – Application of Safety Instrumentation Systems for the Process Industries

c. The Government of Manitoba

1.1.10 C.C.S.M. C W210 – The Workplace Health and Safety Act

D) DEFINITIONS

a. For the purpose of this Practice, the following definitions apply:

i. Accessible: Term applied to a device or function that can be used or seen by an operator for the purpose of performing control actions (e.g. set point changes, auto-manual transfer, or on/off actions) (Reference ISA 5.1)

ii. Automated Valve: Any valve with a locally or remotely controlled actuator. Examples are throttling control valves and on/off block valves. Actuators are typically air-operated (diaphragm or piston), electric or hydraulic, some with spring return function. Manually operated valves are sometimes tagged as automated valves (e.g., if a manual valve is fitted with position switches).

iii. Auxiliary P&ID: Used to show details to unclutter other P&IDs (e.g., lube oil system, sample systems, instrument details).

iv. Basic Process Control System (BPCS): Control equipment and system installed to regulate normal production functions. It may contain combinations of single-loop pneumatic controllers, single-loop electronic controllers, Programmable Logic Controllers (PLCs), Supervisory Control and Data Acquisition (SCADA) and Distributed Control Systems (DCSs). The BPCS is required to operate the process. Examples of control functions included in the BPCS are cascade control, override control, and pump start/stop. Also known as Basic Regulatory Controls. (See also HLCS and SIS).

v. Bubble: Circular symbol used to denote and identify the purpose of an instrument or function. The bubble usually contains a tag number. (Synonym for balloon) (Reference ISA 5.1).

vi. Design Pressure: Pressure used in the design of a vessel component together with the coincident design metal temperature for determining the minimum permissible thickness or physical characteristics of the different zones of the vessel. (Reference ASME Boiler Pressure Vessel Code, Section VIII, Division 1, Appendix 3)

vii. Fail Closed (FC): Characteristic of an automated valve that causes the valve to close as a result of specific malfunctions, including loss of signal or motive power. (Reference ISA 5.1).

viii. Fail Indeterminate (FI): Characteristic of an automated valve that causes the valve to move to an unknown position as a result of specific malfunctions, including loss of signal or motive power. Some automated valves will not stay at the last position upon failure and instead move with the process differential pressure. Additional equipment may be needed to meet the definition of FC, FO, or FL. (Reference ISA 5.1).

ix. Fail Locked (FL) Last Position: Characteristic of an automated valve that causes the valve to remain in the last (locked) position as a result of specific malfunctions, including loss of signal or motive power. Automated valves may fail indeterminately without additional equipment. (Reference ISA 5.1).

x. Fail Open (FO): Characteristic of an automated valve that causes the valve to open as a result of specific malfunctions, including loss of signal or motive power. (Reference ISA 5.1).

xi. Hand Switch (HS): Any operator-manipulated discrete control device, including hardwired panel switches and software points.

xii. Heat Exchanger Type: Type designation shall be shell and tube, plate and frame, spiral, etc. For shell and tube exchangers, use the three-letter designation describing stationary head, shell, and rear end or head, in that order, in accordance with TEMA.

xiii. Higher Level Control System (HLCS): Provides sophistication above that of the BPCS. The HLCS is not necessary to operate the process. HLCS functions are typically based in process computers or higher level DCS hardware that interacts with the process by manipulating set points in the BPCS. Examples of control functions in the HLCS are statistical process control and model predictive control. (See also BPCS and SIS).

xiv. Interlock: System that, in response to a predetermined condition, initiates a predefined action. Typically comprised of binary (on/off) signals and logic used for process control, sequencing, or protective interruption of normal process control functions. Protective interlocks are typically further defined as being either safety-related or commercial-related (asset or production protection).

xv. Isolation Valve: A valve used for isolation of process equipment while performing activities such as purging, de-pressuring or de-inventorying. This valve is also commonly referred to as the primary block valve.

xvi. Line Class: Section of the Piping Material Specifications that provides a listing of piping components for specific design conditions.

xvii. Logic Solver: Control equipment that performs the logic function. It can be either hardwired (e.g., relays) or Programmable Electronic Systems (e.g., DCS-based or PLC-based, including dual-redundant or triple-redundant microprocessors).

xviii. Packaged Equipment: One or more pieces of equipment furnished by a vendor with supportive devices and components to perform a specific operation as a unit.

xix. Process and Instrumentation Diagram (P&ID): Detailed graphical representation of a process including the hardware and software (i.e., piping, equipment, and instrumentation) necessary to design, construct and operate the facility. Common synonyms for P&IDs include Engineering Flow Diagrams (EFDs), Utility Flow Diagrams (UFDs), and Mechanical Flow Diagrams (MFDs).

xx. Programmable Electronic System (PES): Logic performed by programmable or configurable devices (Reference ISA 84.01).

xxi. Root Valve: First valve or valves between the process and an auxiliary device (e.g., an instrument) that contacts the process and is used to isolate the device from the process. This valve is typically a line class valve used for shut-off and isolation.

xxii. Safety Integrity Level (SIL): One of four possible discrete integrity levels (SIL 1, SIL 2, SIL 3, and SIL 4) of Safety Instrumented Systems. SILs are defined in terms of Probability of Failure on Demand (PFD). (Reference ISA 84.01).

xxiii. Safety Instrumented Systems (SIS): Systems composed of sensors, logic solvers, and final control elements for the purpose of taking the process to a safe state if predetermined conditions are violated. Other terms commonly used include Emergency Shutdown System (ESD or ESS), Safety Shutdown System (SSD), and Safety Interlock System (SIS). (Reference ISA S84.01) (See also BPCS and HLCS).

xxiv. Skirt: Cylindrical supporting structure, welded to the bottom of a vertical vessel and extended to the base support.

xxv. Tagged: For the purposes of labeling instrumentation and control components, a hardware device or a software point that is identified with a W&W or ISA style tag number.

xxvi. Tight Shut-Off (TSO): Tight Shut-Off is defined in this Practice as ANSI Class V or ANSI Class VI in accordance with ANSI/FCI 70-2.

xxvii. Trim: Item attached to equipment as an integral component, identified as part of the equipment that is exposed to the process, and having a function local to the equipment being served. Examples are vent and drain valves, instrument bridles, blind flanges, plugs, or other miscellaneous items associated with a piece of equipment. Typically, trim is purchased independently from the equipment

E) GENERAL REQUIREMENTS

a. Most details available from other types of documentation (e.g., instrument loop diagrams and vessel data sheets) should not be included on P&IDs.

b. This appendix uses the concepts of typical details with implied components where appropriate to simplify P&IDs.

c. While the intent of this appendix is to simplify the P&IDs through the use of implied components and cover sheets, this may not be compatible with the work processes or design software used for a project. Therefore, this Practice does not require the use of implied components. It is the responsibility of the project team to determine the compatibility of implied components with project needs and work.

F) DRAWING LAYOUT

Comment: The layout and orientation statements specified herein are recommended as optimal and slight deviation, although not encouraged, may be required due to space constraints.

a. General

i. Drawing size shall be consistent with the other drawings in the tender documents.

ii. Each P&ID shall be laid out to avoid clutter and allow future modifications. No more than three pieces of major equipment shall be shown on a single P&ID. A set of pumps in the same service shall be one piece of equipment for the purpose of a P&ID layout.

iii. Equipment arrangement shall be shown relative to its elevation to grade where practical.

iv. A control valve actuator shall be shown above a horizontal line or left of a vertical line.

v. Typical details shall be used if clutter can be eliminated without detracting from clarity. These details shall be shown on the P&ID, on an auxiliary P&ID, or on a cover sheet

b. Flow Orientation

i. Primary flow shall be shown on each P&ID from left to right. Flow through equipment shall be shown relative to the actual arrangement, such as filter influent in the top of the tank and filter effluent out the bottom of the tank.

ii. Primary process lines shall be shown as a heavier line weight than secondary and utility lines.

c. Connectors

i. Off-page connectors for primary, secondary, and instrumentation lines shall be shown entering the P&ID horizontally from the left inside the borderline and existing horizontally from the right inside the borderline.

ii. Service description, connector number, P&ID number and origin/destination shall be shown for off-page connectors.

iii. Origin/destination shall be shown as an equipment tag, line number or loop number.

iv. Service description for a piping off-page connector shall be shown as name of fluid or line description.

v. Service description for instrumentation off-page connector shall be shown as a line function or equipment to be controlled.

vi. Text associated with off-page connectors on the left side of the P&ID should be left justified; text associated with offpage connectors on the right side of a P&ID should be right justified.

d. Equipment

i. Information

1. Equipment numbers shall be underlined.

2. Equipment descriptions and data shall be immediately beneath the equipment number.

3. Equipment information for fixed or static equipment (e.g, tanks, vessels, filters, etc.) shall be shown immediately below the top boaderline and motorized/rotating equipment (e.g., pumps, blowers, compressors, etc.) shall be shown immediately above the bottom borderline. Equipment numbers for the top or bottom identification shall be on the same horizontal plane as other equipment identification.

ii. Symbols

1. Equipment symbols shall be as indicated in the facility P&ID legends where applicable or available.

2. Equipment shall be shown with a simple outline representation.

3. Discretion shall be exercised for equipment symbols to not dominate the drawing, but the symbols shall be drawn large enough for clear understanding.

4. Equipment shall not be drawn to scale.

5. Equipment shall be shown relative to associated equipment both in size and general orientation.

iii. Nozzles

1. Nozzles, including spares, shall be shown on equipment as single lines.

2. Manways shall be shown as double lines.

3. Process and utility nozzles may be labeled.

4. Nozzle sizes shall be shown, unless the size is implied by piping connections.

iv. Equipment identification shall be in accordance with Water and Waste Identification Standards.

v. Equipment elevations shall not be shown unless the elevations are necessary to specify process requirements for associated equipment location or orientation relative to one another.

vi. Associated trim (e.g., vents, drain valves, etc.) for equipment shall be shown.

vii. Jacketing and tracing requirements for equipment shall be shown.

viii. The type of insulation (e.g., personnel protection, heat conservation) for equipment shall be shown as part of the equipment data. Insulation thickness shall be shown where applicable.

ix. Drivers shall be shown with driven equipment and shall use the symbols for motors, and diesel/natural gas engines.

e. Instrumentation and Controls

i. Symbols

1. Instrumentation and control symbols shall be as indicated in the facility P&ID legends where applicable or available.

2. If necessary a descriptive text label may be added (e.g.

3. Directional arrows on instrumentation signal lines shall be used only if the function is not obvious.

4. Instrument function symbols shall be used to clarify the function of certain tagged instrument bubbles. The symbol shall be placed outside the bubble at the upper right.

ii. Automated Valves

1. Automated valve fail actions shall be shown with text (i.e. FO/FC/FI/FL)

2. Valves with different fail actions for loss of signal and for loss of motive power require an explanatory note.

3. Valve body sizes shall be shown for all automated valves if not line sized or otherwise implied.

4. For automated valves, tight shut-off requirements shall be identified by using the abbreviation “TSO”.

APPENDIX G – AUTOMATION ENGINEERING REQUIREMENTS

PART B - PLC PROGRAMS

B1. PLC PROGRAM LANGUAGE

B1.1 The Schneider Electric Modicon PLCs support all five languages defined by IEC 61131-3. However, the specific language used for an application must be selected as per Table G1. Note that more than one programming language may be used within a single PLC program.

Table G1: Permitted PLC Programming Languages

Language	Permitted	Notes
Function Block Diagram	Yes	Preferred for most general applications
Ladder Diagram (Ladder Logic)	Yes	Permitted for specific logic applications with minimal analog control
Instruction List	Not Generally	May be considered for a very specific subroutine requiring high performance
Structured Text	Yes	Appropriate for certain math and logic applications
Sequential Function Chart	Not Generally	May be considered for complex sequencing applications when difficult to implement in a different language.

B2. PLC CONFIGURATIONS AND PROGRAM LOGIC

B2.1 All PLC configurations and program logic shall be fully accessible and editable by the City of Winnipeg. PLC systems that are password protected, and as a result made inaccessible for modification by the City for any reason, will not be accepted under any circumstance. This applies to PLC systems used in any application, including process and HVAC applications.

B2.2 A standard library of function block classes are available and it is expected that new PLC programs be implemented with these function block classes. Where an existing function block class does not provide the required functionality, develop a new function block class and add it to the library for re-use.

B2.3 Programs are to be implemented using an object-oriented approach, utilizing user-defined data types and encapsulation where possible.

B2.4 Programs are to be implemented using positive logic, meaning that discrete variables are to be named based on the function they perform in the 1 State (True State).

B2.5 Use state machine logic for state-based and sequencing applications.

B2.6 Refer to the City of Winnipeg Tag-name Identification Standard, document code 612620-0014-40ER-0001, for standards regarding naming of tags and function block classes.

B3. PROGRAM STRUCTURE

B3.1 Segregate programs into multiple tasks and routines to improve readability and maintenance of the program.

B3.2 The name (identifier) of all tasks and routines shall contain the identifiers of the equipment they are associated with. Exceptions to this rule include system tasks that cannot be renamed, and routines that are not directly associated with equipment such as input/output mapping routines. When using periodic tasks, the priority number and scan rate of the task shall be included in the name of the task.

B3.3 The name for each X80 RIO adapter in the configuration shall include the physical rack identifier and the assigned drop number per the rotary switches on the front of the module.

B3.4 The name for each X80 I/O module in the configuration shall include the rack identifier and slot number in which the module is installed.

B4. PROGRAM DOCUMENTATION

B4.1 Provide complete documentation within PLC programs to aid in full understanding of the logic. Note that the level of documentation expected is greater than what an experienced programmer would need, since the programs may be viewed and maintained by personnel who may not have substantial programming experience, or may not be fully familiar with “class based” function block programming.

B4.2 Where documentation is provided for specific logic, avoid creating documentation that simply repeats the logic. Documentation should describe the functionality of the logic. For example, avoid saying “the A bit turns off the B bit after 10 seconds”. Instead, say “the discharge pressure sensor turns off the motor after it indicates low pressure for 10 seconds”.

B4.3 All routines shall contain a documentation header containing the authoring company name, the date the routine was created, the current revision number of the routine, date of the latest revision, and the document number of the associated Functional Requirements Specification if applicable.

B5. VARIABLE DATA TYPES

B5.1 For each variable tag, use a data type that results in the least amount of memory usage while still providing the required number of significant figures.

B5.2 For all digital (On/Off or True/False) variables, use the EBOOL data types.

B5.3 For analog integer variables in the range of -32768 to +32767, use the INT data type (16 bits).

B5.4 For analog integer variables in the range of -2147483648 to +2147483647 and that exceed the range of the INT data type, use the DINT data type (32 bits).

B5.5 Use of UINT or UDINT is to be avoided to ensure that the data is not misconstrued as being signed data by an ancillary system (e.g. Microsoft Excel).

B5.6 For non-integer analog data, use the REAL data type. Do not use the INT or DINT data types with an implied decimal for storing non-integer data.

B6. CONTROL MODES

B6.1 Process equipment may be controlled from a number of sources including the PLC system, panel instruments, and manual pilot devices. Operator controls shall be provided on the HMI system and/or in the field for selection of the active control source.

B6.2 The following equipment operating modes have been defined.

(a) PLC Only – The equipment is always controlled by the PLC, although may be switched between Manual and Auto modes via the HMI. Manual controls are provided on the HMI.

(b) Local/Off/Remote – A Local/Off/Remote switch is provided at the equipment or at the motor controller (e.g. MCC, or VFD). When in Local mode, the equipment is controlled via the local pilot devices. When in Remote mode, the equipment is controlled from the PLC system.

(c) Hand/Off/Remote – A Hand/Off/Remote switch is provided at the equipment or at the motor controller. When in Hand mode, the equipment runs continuously. When in Remote mode, the equipment is controlled from the PLC system.

(d) Hand/Off/Auto – A Hand/Off/Auto switch is provided, with the Auto mode providing automatic equipment control via a controller other than the PLC system.

B6.3 Using the “Auto” designation for PLC system control is not recommended as this designation can conflict with the HMI Auto/Manual modes that may be provided on the HMI/PLC system.

B6.4 Where Local/Off/Remote or Hand/Off/Remote switches are provided, connect one of the “Remote” position contacts to a PLC input and program the PLC such that its outputs associated with the equipment is only enabled when in Remote mode.

B7. CYBER SECURITY

B7.1 Security controls and safeguards shall be provided with all new PLC system and network installations to prevent internal and external threats from affecting plant assets through system vulnerabilities.

B7.2 Security controls and safeguards are divided into the several categories including:

(a) Corrective – Controls that minimize the effect of an attack and the degree of resulting damage;

(b) Detective – Controls that determine if an attack has occurred, or is in the process of occurring, and initiate corrective controls;

(c) Deterrent – Controls that reduce the ease in which an external threat can affect assets; and

(d) Preventative – Controls that prevent external threats from affecting assets.

B7.3 Controls and safeguards shall be provided to protect against the various types of attacks which include:

(a) Passive – Monitoring, capture, and analysis of communication, and decrypting weakly encrypted data;

(b) Active – Attempts to circumvent or break encryption, modify information, and introduce malicious code;

(c) Close-In – Attaining close proximity to system components to learn about the implementation and modify, gather, or deny access to information;

(d) Spoof – Modification of the source address of packets the attacker is sending so that they appear to be originating from someone or something else;

(e) Buffer Overflow – Sending more data to a system than is expected, causing complete failure or unexpected operation of the system; and

(f) Hijack – Taking over a session between two systems and disconnecting one of the systems from communication.

B7.4 Network firewalls, gateways, and encryption shall be used at appropriate points within the networks to inspect and control network traffic as a means to mitigate attacks. Firewalls shall use techniques such as packet filtering, stateful inspection, deep-packet inspection, and rate limiting.

B7.5 Firewalls used in the process control system network shall be purpose-built for process control systems, and shall be able to perform packet inspection on common industrial Ethernet protocols such as Ethernet/IP and Modbus/TCP. For example, the following mechanisms shall be provided for Modbus/TCP enforcement.

(a) User-definable lists of allowed Modbus unit IDs, commands, registers, and coils.

(b) Protocol “sanity check” blocks any traffic not conforming to the Modbus standard.

(c) Automatic blocking and reporting of traffic that does not match the rules.

B7.6 Firewalls shall also incorporate a logging mechanism to allow for routine inspection of event messages to determine if attacks have been attempted, have occurred, or are in progress. In addition to internal logging, the device shall be capable of logging to an external (syslog) monitoring system.

B7.7 Encryption shall be used for all wireless communication and any inter-plant communication that uses the Internet. Wireless (Wi-Fi) networks shall not use Wired Equivalent Privacy (WEP) as it is easily breakable even when configured correctly. Wi-Fi networks shall use WPA or WPA2 encryption. At minimum, Virtual Private Networking (VPN) shall be used for inter-plant communication or anywhere the Internet is required for transmission of data associated with the process control system.

B7.8 All Ethernet network switches shall be managed switches and have all unused ports disabled. Network switches shall be password protected.

B7.9 All process control system devices that incorporate password protection shall be configured with a password other than the default password. The same password should not be used on multiple devices.

B7.10 Field devices that incorporate physical DIP switches or jumpers to prevent write access to the device and do not require frequent configuration changes should be set read-only to prevent unauthorized or accidental change.

B7.11 Demilitarized zones with upstream and downstream firewalls should be used for access to such systems as an Information Server and a read-only HMI terminal server. These systems shall still incorporate authentication mechanisms and credentials to prevent access by unauthorized users. Systems in demilitarized zones shall be configured read-only.

B7.12 Restrict physical access to process control system equipment, including programmable controllers, network switches, and field devices. This may be achieved via a lock on the enclosure containing the devices, or placing the devices in a locked room.

B7.13 Disable unused services on computer servers to improve security and performance.

B7.14 Configure user and group security appropriately; do not grant unnecessary privileges.

B7.15 Avoid use of personal or commercial grade hardware and software components (e.g. virus scanning and firewall software) that may be incompatible with process control system components. For example, some firewall software may block network packets that are required for redundant HMI server synchronization and may prevent failover of the HMI server. Be aware of such issues, and properly configure and test all components.

B7.16 Computers associated with the process control system shall not be directly connected to the Administration or Security networks. Similarly, computers on the Administration or Security networks shall not be directly connected to the Process Control System Network. Where connections between networks are required, they shall occur through firewalls.

B7.17 Components providing system security shall be implemented in a manner that failure of the component acts to disable system functionality rather than disable system security.

B7.18 Use the following standards and guidelines when implementing system security:

(a) NIST Special Publication 800-82, Guide to Industrial Control Systems (ICS) Security;

(b) ISA/-62443 (formerly ANSI/ISA-99.00.01): Security for Industrial Automation and Control Systems;

(c) North American Electric Reliability Corporation (NERC), Critical Infrastructure Protection (CIP) Cybersecurity Standards;

(d) NIST Special Publication 800-53, Recommended Security Controls for Federal Information Systems;

(e) Department of Homeland Security, Catalog of Control Systems Security: Recommendations for Standards Developers;

(f) AMI-SEC Task Force, AMI System Security Requirements; and

(g) DOD Instruction 8500.2, Information Assurance (IA) Implementation.

B8. DELIVERABLES

B8.1 All deliverables are to be sealed by a qualified professional engineer.

PART C - AUTOMATION ENGINEERING DOCUMENTS

C1. GENERAL

C1.1 All drawings and other deliverables related to a design are the responsibility of the design engineer.

C1.2 All automation deliverables are to be sealed by a qualified professional engineer.

C1.3 All drawings shall be comprehensive in nature to allow for effective use in construction and maintenance.

C1.4 The project includes additions, expansions, upgrades, or modifications to an existing site and facilities, up-date existing drawings.

(a) Loop drawings, motor schematics, and wiring diagrams must always be updated.

(b) PLC system I/O schematic drawings must always be updated.

(c) Updates to or superseding existing P&ID drawings is mandatory. Partial P&ID diagrams showing a small portion of the process modifications are not acceptable.

(d) Update of existing instrument plan drawings to reflect new work.

C1.5 Clearly indicate all demolition requirements on the drawings and in the specifications. Where demolition requirements are significant, create dedicated demolition drawings. Generally

abandoned equipment, wiring, etc. shall be removed unless specifically requested by the City that the equipment/wiring be retained, or removal is not practicable.

C1.6 Acceptance testing requirements shall be defined for every project. Acceptance tests shall use industry approved methods. Acceptance testing forms shall be completed for every project and included with the operations and maintenance manuals/Information. The Design Team is responsible for reviewing the completed acceptance test forms to ensure that the installation complies with the specifications.

C2. DRAWINGS

C2.1 General

(a) The automation drawings produced shall be comprehensive to cover the scope of the project, and shall be detailed to an “industrial” level of detail. “Commercial-grade” drawings that have excessive use of “typical” and general lack of detail are not acceptable.

(b) The title block format shall be acceptable to the City and utilize a City issued drawing number and include a revision table.

C2.2 Loop Drawings

(a) Loop diagrams shall be developed for:

(a) each installed instrument and device during detailed design for the tender ready documents. Typical loop diagrams are not acceptable; and

(b) typical loop diagrams for each type of instrument and device for preliminary designs.

(c) This Work requires the generation of new Instrument Loop Diagrams and does not apply to the revision of existing instrument loop diagrams. This Work also applies to Instrument Loop Diagrams provided by packaged equipment vendors and contractors.

(d) Existing facilities do not necessarily comply with these requirements. The expectations regarding application of these requirements to existing facilities must be decided on a case-by-case basis in consultation with the Project Manager, however general guidelines for application are presented as follows:

(a) All new facilities must comply completely.

(b) All major upgrades to a facility, or a larger facility’s process area, must completely comply. Any existing instruments within the area being upgraded and incorporated in to a new PLC system should be re-identified.

(c) All minor upgrades should utilize these requirements as far as practical for new instruments, however in some cases compromise with the existing practice may be required.

(d) All components of the loop and the loop itself, including connections to multi-point devices, programmable logic controllers, power sources, etc should be identified (all instrument numbers should agree with the P&ID).

(e) Divide the drawing into columns such that each column represents a physical location. Title each column with the physical location it represents.

(f) The loop diagram should include word descriptions of loop functions. The title should be adequate and include the device identification tag. Descriptions of special functions and features that are not obvious, especially safety and shutdown circuits, should be given.

(g) All interconnections with electrical cables, conductor pairs, pneumatic multi tubes, and individual pneumatic and hydraulic tubing should be shown (this includes junction boxes, terminals, bulkheads, ports, and computer input/output, such as I/O connections, grounding systems, grounding connections, and signal levels). All interconnections should be uniquely identified and clearly labeled per the City of Winnipeg Water and Waste Department Identification Standard.

(h) The location of devices should be identified using descriptors such as field, field terminals, control cabinet, PLC section, rack and slots.

(i) Electrical power, air and hydraulic supplies, including the designated voltage and pressure values, should be shown.

(j) Provide all instrument and/or device settings on the loop drawing, such as dip switch settings, dial settings, etc.

(k) For analog loops, such as 4-20 mA and 0-20 mA loops, where there are multiple load devices within the loop, indicate the impedance of each device in the loop.

(l) Supplemental drawings and records should be referenced to show interrelations with other control loops, such as overrides, interlocks, cascades, and shutdowns.

(m) Although loop design often requires input from several different design areas, design responsibility and configuration control of the loop should be centered within a single function.

(n) Descriptions should be given for controller action, control valve action, control valve failsafe action (electronic and/or pneumatic failure), and solenoid valve action.

(o) Calibration information should be shown in consistent units that match the applicable instrumentation index.

(p) Unique identification numbers consistent with other record documents should be shown for equipment such as racks, panels, and junction boxes.

(q) Indicate the source of power (and common / neutral connections) for all loops.

(r) Provide an appropriate symbol within each special terminal to indicate the type of terminal:

(a) Indicate fused terminals with a small fuse symbol inside the terminal. Provide the fuse rating below the terminal.

(b) Indicate disconnect terminals with a small disconnect symbol inside the terminal.

(c) Indicate potential earth terminals with a small ground symbol inside the terminal.

(d) Show the instrument identifier within an instrument bubble symbol adjacent to and pointing at the instrument.

(e) Show all field instrument and control panel device part numbers on loop drawings.

(f) For intrinsically safe wiring, indicate the following:

(a) The classification of the hazardous location (e.g. Class I, Zone 1, Group IIC),

(b) For intrinsically safe apparatuses (field devices) other than simple devices, the manufacturer, model, and entity parameters of the apparatus,

(c) Manufacturer/model and/or permissible entity parameters of the associated apparatus (e.g. IS barrier),

(d) Maximum entity values for the cabling.

(e) Size of Drawing: Loop diagrams shall be prepared as ANSI B (11 x 17 inch) drawings. The smallest letter size shall not be less than 2.5 mm (3/32 inches).

(f) The loop diagram will generally contain only one loop. Special situations may necessitate a combination of loops on one drawing. The drawing should be arranged to prevent congestion and should provide extra space for future revisions. Complex loops that require more than one sheet may be expanded to as many ANSI B sheets as necessary. Adequate continuation points should be provided for proper understanding of the total loop configuration.

C2.3 **Instrument Segment Drawings**

(a) The instrument Segment Drawings shall be prepared for PROFIBUS instruments.

(b) All new PROFIBUS instruments shall be shown on the instrument segment drawings.

(c) Indicate all instrument and networking equipment identifiers.

(d) Indicate the cable identifier and cable type for each cable on the drawing.

(e) Indicate the estimated length for all cables on the drawing.

(f) Indicate allowable minimum and/or maximum cable lengths on the drawing where applicable.

(g) Indicate the network speed(s) on the drawing.

(h) Indicate the location and type of terminations on the drawing.

(i) Indicate the network address number of each device on the drawing.

(j) Provide a Segment Schedule on the drawing, showing the number of devices, total length, and maximum spur length for each segment.

(k) Size of Drawing: Instrument segment drawings shall be prepared as ANSI B (11 x 17 inch) drawings. The smallest letter size shall not be less than 2.5 mm (3/32 inches).

C2.4 **Instrumentation Location Plan Drawings**

(a) All new instruments shall be shown on instrument location plan drawings.

(b) Provide instrument elevation drawings for instruments that are to be installed at a specific elevation and where sufficient detail cannot be provided in plan view.

(c) All instrument identifiers are to appear on the drawings.

(d) All process/mechanical equipment, if applicable, shall be shown with a lighter line weight.

(e) The instrument plan and elevation drawings are to be scaled typically at 1:50 on a standard A1 size drawing.

C2.5 **Instrument Installation Details**

(a) The instrument installation details shall be provided for all instruments that require a specific means of installation.

(b) Show all installation details including instrument orientation, mounting bracketry, cables, conduits, strain reliefs, pull boxes, and junction boxes as applicable.

(c) For magnetic flow meter installations, show grounding ring installation and connection details.

(d) All structural and mechanical equipment, if applicable, shall be shown with a lighter line weight.

(e) Instrument installation details are typically shown as a detail on a standard A1 size with a recommended drawings scale or 1:10 to a maximum of 1:20.

C2.6 **Control Panel Layouts**

(a) Provide control panel layout drawings for all control panels that are to be constructed by a contractor.

(b) Provide a bill of materials, indicating the quantities, manufacturer name, model name, and a description for each component.

(c) Show exterior panel dimensions.

(d) Show the exterior (typically the front door only) elevation of the control panel with all components to scale.

(e) Show the interior elevation panel layout of all components to scale. The only component not shown on the layout shall be the wires.

(f) Where dedicated wireways are required, indicate the type or category of wiring that may be installed in each wireway.

(g) For each terminal block, indicate which side is for field wiring side and which side is for internal wiring.

(h) Provide construction notes indicating specific construction details.

(i) The control panel layout drawings are to be produced on a standard A1 size with a recommended drawings scale or 1:5 to a maximum of 1:10.

C2.7 **Control Panel Power Distribution Schematics**

(a) The control panel power distribution schematics shall be provided for all control panels.

(b) Show the complete schematic for the power distribution, including component identifiers, terminals, terminal numbers, wires, and wire tags.

(c) Show where the source of power terminates to the control panel, and include the name and details of the power source (e.g. “120 VAC from PNL-R731, CCT 12”).

(d) Provide a fuse schedule on the drawing which lists the identifier, type, and rating of each fuse.

(e) Provide a power consumption schedule for each major voltage level used within the control panel that summarizes the current consumption from each device, including PLC

inputs and outputs. The total current consumption shall be provided at the bottom of the table.

(f) Provide a terminal layout (arrangement) on the drawing for terminal blocks associated with power distribution.

(g) The control panel power distribution schematics are to be produced on a standard A1 size drawing.

C2.8 **I/O Module Wiring Diagrams**

(a) The I/O module wiring diagrams shall be provided for all programmable automation controller I/O modules.

(b) Show the I/O modules and their connections to the I/O (field) terminals. The field instruments and associated wiring to the I/O (field) terminals shall not be shown on I/O module wiring diagrams. The field wiring details must be shown on loop drawings or other automation / electrical diagrams.

(c) Provide the I/O signal name and drawing reference beside each set of I/O (field) terminals associated with each I/O point.

(d) Where fused I/O (field) terminals are used, provide a fuse schedule which lists the identifier, type, and rating of each fuse.

(e) The I/O module wiring diagrams shall be produced on a standard A1 size drawing.

C2.9 **Network Diagrams**

(a) The network diagrams shall be provided for all new network equipment installations.

(b) Use an Instrument Segment Drawing for all PROFIBUS instrumentation network drawings. See C2.3.

(c) Existing network diagrams shall be updated where changes are made to an existing network.

(d) Network diagrams shall show all networking equipment, including patch panels, network switches, routers, media converts, wireless devices, and cabling.

(e) The port type (RJ45, FC, LC, ST, SC, etc.) shall be identified on the drawing using a specific symbol.

(f) All port labels and/or port numbers for networking devices shall be indicated on the drawing in a manner that is consistent with the physical port labelling on the device.

(g) All cable identifiers are to be shown on the drawing along with the cable types:

(a) For copper network cables, indicate the number of conductors, conductor size, and type of cable. Example: “4 PR, 24 AWG, CAT 6”.

(b) For fibre cables, indicate the type of fibre (single-mode, multi-mode, hybrid, etc.) number of strands, core diameter, cladding diameter, and signal compatibility.

(c) For long runs of fibre or CAT5e/CAT6 Ethernet cabling, indicate the estimate length of the cabling on the drawing.

(d) For Ethernet Networks, indicate the IP addresses of the devices on the drawing. Note IP addresses are not to be made available to the public.

(e) For Modbus/TCP, Modbus/RTU (serial), or other networks utilizing “Node” numbers, indicate all device node numbers on the drawing.

(f) For outdoor wireless systems, show all antennae and lightning surge arrestors.

(g) Provide a symbol legend on the drawing or on a standard legend sheet.

(h) The network diagrams shall be produced on a standard A1 size drawing.

C2.10 **Automation Conduit Riser Diagrams**

(a) Where conduit sizing for the provision for future wiring is required, an automation conduit riser diagram shall be provided so that conduits are installed with the required spare capacity, and not sized by the installation contactor to the minimum size required by Code.

(b) Show the conduit type and size for each conduit.

(c) Show pull boxes, junction boxes, and panels as required.

(d) Show area boundaries using boundary lines and show each pull box, junction box, and panel within the appropriate boundaries.

(e) Provide a legend on the drawing or a standard legend sheet indicating the acronyms used. Examples:

ARC Aluminum Rigid Conduit

LFMC Liquid-tight Flexible Metallic Conduit

PB Pull Box

PVC Polyvinyl Chloride

(f) The automation conduit riser diagrams are to be produced on a standard A1 size drawing.

C2.11 **Process and Instrumentation Diagrams**

Note: Process and Instrumentation Diagrams are officially categorized under the Process discipline, but rely heavily on input from automation engineers.

(a) See Appendix F.

C3. OTHER DOCUMENTS

C3.1 **Instrumentation List**

(a) An instrumentation list is required for every project where new or city provided instruments are installed.

(b) Provide an overall cover page, indicating client name (City of Winnipeg Water and Waste Department), project title, document title and document revision table. The cover page shall be seal by the Design Engineer.

(c) The instrument list shall include the following fields:

(a) Record Number

(b) Revision Information

(c) Instrumentation Loop Number

(d) Instrumentation Tag

(e) Description of the instrument type

(f) Description of the instrument service

(g) Power Supply

(h) Calibration Range

(i) Communication (4-20 mA, HART, PB DP, etc.)

(j) Mounting Method

(k) Supplied By

(l) Specification Data Sheet

(m) Location Plan Drawing number

(n) P&ID Drawing number

(o) Schematic/Loop Drawing number

(p) Notes

(q) The instrument list shall be prepared in Microsoft Excel or Microsoft Word, other formats may be accepted by the City with approval.

C3.2 **Loop Number List**

(a) The Loop Numbering List lists all of the loop numbers used at each facility to prevent inadvertent duplication of loop numbers and equipment identifiers.

(b) Loop Numbering List is required for all projects where new equipment is installed.

(c) The Loop Numbering List shall be divided by process area.

(d) The Loop Number List shall include the following fields:

(a) Loop Number

(b) Loop/Equipment Description

(c) Reference Drawings (e.g. loop drawings, P&ID drawings)

(d) Notes

(e) Revisions Information

C3.3 **I/O List**

(a) An I/O list is required for every project where changes to PLC system I/O are made.

(b) Where possible, update an existing facility I/O list rather than creating a new I/O list. Alternatively, update the existing facility I/O list upon completion of the project.

(c) Provide an overall cover page, indicating client name, project title, document code, and document revisions. The cover page shall be sealed by the Design Engineer.

(d) I/O lists shall include the following fields:

(a) I/O Module Address (e.g. rack number and/or slot number);

(b) Module Point (I/O point number or channel number on module);

(c) Tag (instrument or signal tag name);

(d) Description;

(e) For discrete I/O:

"0 State" Description (description of signal when FALSE)
"1 State" Description (description of signal when TRUE)
Indicate which state is used for alarms (if applicable)

(f) For analog I/O:

Type (4-20mA, 0-5 VDC, 0-10 VDC, etc.)
EU Range (engineering unit range) including raw min and max if scaling occurs in SCADA rather than in the PLC. Indicate engineering unit of measure

(g) P&ID drawing (reference to applicable P&ID drawing)

(h) Loop/wiring drawing (reference to applicable loop/wiring drawing)

(i) The list shall be grouped by I/O signal type:

(a) Discrete Input

(b) Discrete Output

(c) Analog Input

(d) Analog Output

(e) HART Input

(f) HART Output

(g) An I/O list will typically be prepared in Microsoft Excel or Microsoft Word, but other formats may be accepted by the City with approval.

C3.4 **Interface Maps**

(a) Interface maps are required for projects where a new customizable controller is installed and makes data available to other controllers via a communication link. For example, a new standalone PLC is installed for an fuel oil system system, which is monitored by the facility PLC system using Modbus TCP.

(b) For non-packaged systems, preparation of interface maps falls under the responsibility of the Systems Integrator. The Design Engineer may provide templates to the Systems Integrator for completion.

(c) For packaged systems including equipment and a programmable controller or HMI, preparation of interface maps falls under the responsibility of the vendor.

(d) Interface maps shall include an overall cover page, indicating client name, project title, document code, and document revisions.

(e) Interface maps shall include the following fields:

(a) PLC Register or PLC Tag name;

(b) Protocol Address (e.g. Modbus address);

(c) Description;

(d) Analog Range – Raw;

(e) Analog Range – Engineering Units;

(f) Read/Write;

(g) In the case of packaged control systems alarm limits should also be indicated,

(h) Digital I/O, should identify, register number and bit number and 1 and 0 states (alarm, etc.); and

(i) Notes.

(j) An interface map will typically be prepared in Microsoft Excel or Microsoft Word, but other formats may be accepted by the City with approval.

C3.5 **Automation Cable Schedule**

(a) An automation cable schedule is required for every project.

(b) Provide an overall cover page, indicating client name, project title, document code, and document revisions. The cover page shall be sealed by the Design Engineer.

(c) All control cables shall be uniquely identified on the cable schedule. Cables shall not be entered as typical.

(d) Where individual wires are routed in conduit, the wires shall be identified as an item in the cable schedule. This is not applicable to power wiring for minor circuits, such as lighting, receptacles, etc.

(e) Cable schedules shall include the following fields:

(a) Cable Identifier,

(b) Cable Type,

(c) From (Source),

(d) To (Destination),

(e) Spacing (typically not applicable to automation cabling),

(f) Length (estimate),

(g) Routing (brief description),

(h) Notes, and

(i) Revision of last change.

(j) The length for each cable shall be estimated at design time to within ~10% accuracy for purposes of pre-bid cost estimating.

(k) A cable schedule will typically be prepared in Microsoft Excel or Microsoft Word, but other formats may be accepted by the City with approval.

C3.6 **Lamacoid Schedule**

(a) A lamacoid schedule is a requirement for every project. Note that the creation of a lamacoid schedule at design time greatly assists the contractor, helps provide a higher quality of identification lamacoids for maintenance personnel, and can be created for a

minimum effort above that required to thoroughly review a contractor-produced lamacoid schedule.

(b) Provide an overall cover page, indicating client name, project title, document code, and document revisions.

(c) All automation lamacoids shall be uniquely identified on the lamacoid schedule, except lamacoids for cables may reference the cable schedule.

(d) Lamacoid schedules shall at minimum include the following fields:

(a) Item

(b) Line 1 (text to appear on row 1)

(c) Line 2 (text to appear on row 2)

(d) Line 3 (text to appear on row 3)

(e) Text size

(f) Notes

(g) Revision of last change.

(h) A lamacoid schedule will typically be prepared in Microsoft Excel, but other formats may be accepted by the City with approval.

C3.7 **Process Control Narrative**

(a) Provide a Process Control Narrative for all projects where new process equipment is installed. While this document is primarily written by process engineers, the automation engineers should review and provide input.

(b) Provide an overall cover page, indicating client name, project title, document code, and document revisions.

(c) Provide a listing of reference drawings (typically P&IDs).

(d) Provide equipment and instrument listing, complete with identifiers (tag numbers) and descriptions.

(e) Provide a detailed textual description of all the control modes of the process.

(f) Indicate general arrangement details, such as equipment physical locale and configuration where required to clarify the process control.

(g) For each operating mode describe the normal operation of each piece of equipment.

(h) Describe the operation of equipment under abnormal circumstances (e.g. instrument failure, mechanical failure, etc.), where possible.

(i) Indicate special requirements of the automation system to accommodate maintenance activities, as required.

(j) Indicate operating setpoints for each operating mode.

1.1.1.1 Indicate process interlocks and major equipment protection interlocks. Standard interlocks (i.e. motor overload) can be detailed in the Functional Requirements Specification (1.1.2).

1.1.1.2 Indicate required major alarms. The complete set of alarms will be in the Functional Requirements Specification.

1.1.1.3 A process control narrative will typically be prepared in Microsoft Word, but other formats may be accepted by the City with approval.

1.1.2 **Functional Requirements Specifications**

1.1.2.1 Provide a Functional Requirements Specification (FRS) for all projects where programming of a PLC or similar system is required.

1.1.2.2 Specific functional requirements for each piece of equipment in the design that is controlled by the programmable controller.

1.1.2.3 Provide textual descriptions, cause-effect matrices, or high-level function block logic diagrams of the required equipment functionality as required.

(k) Use pseudo-code and function block logic diagrams only when necessary, i.e. when it is not possible to convey functionality using alternate means.

(l) Textual descriptions should be used to provide a general understanding where required, but should not be used alone to describe detailed logic.

1.1.2.4 Functional requirements specifications are typically prepared in Microsoft Word, and may reference external documents such as cause-effect matrices that were generated using Microsoft Excel.

1.1.2.5 Functional Requirements Specifications are split into multiple documents as follows:

(a) A Standard Function Block Class FRS – contains the standard set of function block classes that are used within the process control system associated with the City's Water Treatment Program. Standard function block classes provide high-level functionality for equipment monitoring and control and can be saved into a repository for re-use.

(b) One or more Process Area FRSs – specific functional requirements specifications for the equipment controlled by the PLC system. The specific FRSs are broken down by process area so that they are manageable in size. If the work associated with the project is all within one process area then only one Process Area FRS would be provided. If the work spans multiple process areas then one FRS would be provided for each process area.

1.2 CONSTRUCTION AND COMMISSIONING DOCUMENTS

1.2.1 GENERAL

1.2.1.1 Provide a header section at the top with the following fields, to be filled in by the contractor for Facility, Project Name, Plant Area, Tender number, and Document number

1.2.1.2 Provide a sign-off section at the bottom. Test forms and checklists are to be signed and dated by the tester and a witness, where the witness is a person designated by the Contract Administrator.

1.2.1.3 Forms and checklists will typically be prepared in Microsoft Word, but other formats may be accepted by the City with approval.

1.2.1.4 Test forms and checklists shall be prepared by the Design Engineer and filled in by the installation contractor.

1.2.2 INSTRUMENT TEST FORMS

1.2.2.1 Instrument test forms shall be provided with projects where new instruments will be installed.

1.2.2.2 Provide sections for filling in the following:

(a) Sensor / element and transmitter details indicating at minimum the units, design range, and configured range;

(b) Inspection of instrument and installation;

(c) For discrete instruments the setpoint trip point, the actual trip point, the setpoint time delay, the actual time delay, and the verification of the signal for each discrete state;

(d) For analog instruments, verification of the signal under various process or test conditions; and

(e) For PROFIBUS instruments, the communication is functioning without error, the transmitter alarms are configured (as required), and the transmitter configuration is complete and saved.

1.2.3 I/O MODULE TEST FORMS

1.2.3.1 I/O module test forms shall be provided for new PLC installations for verification that each I/O point and associated HMI object(s) are configured correctly.

1.2.3.2 Provide a section for filling in the associated PLC identifier, PLC description, rack number, slot number, and module type.

1.2.3.3 Provide separate forms for each type of module (discrete input, discrete output, analog input, analog output, thermocouple input, RTD input, etc.).

1.2.3.4 Provide columns within the forms for the I/O point number, I/O point tag name, I/O point description, 0 State (False state) description, 1 State (True state) description, and checkboxes for indicating that each state has been verified:

(a) at the PLC Input/output module,

(b) on the HMI graphic display, and

(c) on the HMI alarm system.

1.2.4 PLC SYSTEM COMMISSIONING CHECKLIST

1.2.4.1 PLC system commissioning checklists shall be provided for new PLC installations for verification that each PLC system is installed and operating correctly.

1.2.4.2 Provide a section for filling in the PLC identifier, PLC description, processor and network adapter module numbers, and rack number.

1.2.4.3 Provide a section indicating that the following has been inspected:

(a) PLC cabinet is completely clean and there are no loose papers inside;

(b) Ventilation openings are not covered;

(c) Drawings are marked up as-built;

(d) Communications between PLC and HMI system is acceptable;

(e) Communications between PLC and remote racks is acceptable, as applicable;

(f) For redundant PLC applications, failover functionality from primary rack to secondary (standby) rack, then back to primary, is operational; and

(g) Memory card(s) are installed and program has been transferred to the memory card(s), as applicable.

1.2.4.4 Provide a section for filling in the following run-time information:

(a) Percentage processor (CPU) utilization;

(b) Percentage memory utilization; and

(c) Program scan time.

1.2.5 ACTUATOR (VALVE OR DAMPER) COMMISSIONING CHECKLIST

1.2.5.1 Actuator commissioning checklists shall be provided for all new actuator installations for verification that the actuator is correctly installed and configured.

1.2.5.2 Provide a section for filling in the valve actuator details:

(a) Identifier (tag);

(b) Description;

(c) Manufacturer;

(d) Model;

(e) Serial Number;

(f) Design Range; and

(g) PROFIBUS network address

1.2.5.3 Provide a section indicating that the following has been inspected:

(a) Actuator type and materials matches the P&ID and actuator data sheet;

(b) Installation of actuator is correct;

(c) Equipment tag is correct;

(d) Configuration matches valve actuator settings sheet;

(e) Open/close/position command from process control system is functioning;

(f) Status monitoring by process control system is functioning;

(g) Drawings are marked up as-built; and

(h) HMI graphic symbol, tag, and units are correct.

1.3 DESIGN CALCULATIONS AND STUDIES

1.3.1 GENERAL

1.3.1.1 All design decisions leading to important design activities, must be supported by an appropriate calculation, which may be required for verification and justification. The Design Engineer shall prepare design calculations as required. It shall be the responsibility of the Design Team to collect, verify, and file all such calculations.

1.3.1.2 The software tools or vendor PLC packages used for the required calculations must be approved by the Lead Engineer for each specific project.

1.3.1.3 Calculations done by subcontractors, contractors or vendors will be permitted if the calculation requires specialized knowledge or experience that a typical automation design engineer would not possess. In these cases, it is the responsibility of the design engineer to ensure that the calculations follow all City standards and guidelines.

1.3.1.4 The calculations and studies shall only be deferred to the contractor after review and agreement with the City.

1.3.1.5 The following are potential calculations that may be required by the design engineer depending on the size and complexity of the design:

(a) New control panels, power supply panels, networking panels:

(i) Wireway sizing / fill calculations, where there are a significant number of wires in the wireways and the percent fill is non-trivial,

(ii) Heat load calculations, and

(iii) Power supply loading calculations.

(b) Wireway sizing/fill calculations for new junction boxes where there are a significant number of wires in the wireways and the percent fill is non-trivial.

(c) Intrinsically safe installations:

(i) Indication of manufacturer, model number, and entity parameters of the intrinsically safe apparatus as they apply to the specific set(s) of terminals to be connected.

(ii) Indication of manufacturer, model number, and entity parameters of the associated apparatus as they apply to the specific set(s) of terminals to be connected.

(iii) Calculation of maximum allowable interconnecting cable entity parameters.

(d) Size (volume) and loading (weight) calculations for the installation of cable trays.

(i) Cable tray sizing (volume) and loading (weight) calculations.

(e) Fill calculations for conduit installations.

(f) Safety Integrity Calculations.

(g) Profibus installations:

(i) Bus voltage drop calculations.

(ii) Bus current (loading) calculations.

(iii) Max bus cable length (trunk and spur) calculations based on network speed and topology.

1.3.1.6 All design calculations relating to process control system performance and utilization should be included in the Operation and Maintenance Manuals for the associated areas.

APPENDIX H – DESIGN CALCULATION REQUIREMENTS

TABLE H-1 CALCULATIONS FOR ELECTRICAL DESIGN

Calculation	Description	Required Tools[1]	Always Req'd	Cond. Req'd[2]	Resp.[3]	Available for Review % Design Phase/ Const
Load - facility, switchgear, MCC	Load at each load center per CEC to determine bus, protective device & circuit size	SKM PTW DAPPER, spreadsheet, hand calcs	X		Consultant	30/60/90
Load - panelboard	Load on each panelboard per CEC to determine panel, circuit, and transformer size	SKM PTW DAPPER, spreadsheet	X		Consultant	60 and 90
Generator sizing	To size engine generator based on critical run and start loads.	Cat, Kohler, Cummins, or other vendor software	X		Consultant	30/60/90
Short Circuit	Available fault current at each bus to determine equipment short circuit/interrupting ratings	SKM PTW DAPPER, Hand Calculation	X		Consultant	30/60/90
Lighting	To determine fixtures needed given desired light level; also energy calculations where required	AGI 32, Vendor, spreadsheets	X		Consultant	60 and 90
Conductor Sizing	To size circuit breakers and fuses per CEC	Tables, hand calcs	X		Consultant	60 and 90
Circuit breaker and fuse sizing	To size circuit breakers and fuses per CEC	Tables, hand calcs	X		Consultant	60 and 90
Conduit Fill/Tray Size	To size conduit and cable tray per CEC	CEC Tables, Cablematic Plus	X		Consultant	60 and 90
Voltage Drop	For heavily loaded and/or long circuits to confirm operation within CEC recommendations (min)	SKM PTW DAPPER, spreadsheets, hand calcs		X	Consultant	60 and 90
Transient Motor Starting	For starting large motors (largest motor at each load center) to determine if voltage drop on motor starting is magnitude to adversely impact other	SKM PTW TMS, hand calcs		X	Consultant	60 and 90

Calculation	Description	Required Tools[1]	Always Req'd	Cond. Req'd[2]	Resp.[3]	Available for Review % Design Phase/ Const
	system equipment (i.e. 20% voltage dip could make control relays drop out)					
Harmonic Distortion Analysis	To confirm operation within IEEE 519 requirements (min) for non-linear loads	SKM PTW HI_WAVE, GE or other vendor software		X	Consultant	30/60/90
Multiple circuit derating	For more than 3 current carrying conductors in a conduit per CEC	CEC Tables, Cablematic Plus		X	Consultant	60 and 90
Ambient temperature circuit derating	For higher than "normal" ambient temperatures--could include heat from multiple circuits in duct bank	AMP CALC, NEC tables		X	Consultant	60 and 90
Protective device coordination	To minimize outages to smallest portion of system possible	SKM PTW CAPTOR		X	Consultant	90
Cable Pulling	To assure no damage to cable when pulled in conduit given conduit size, distance and bends. Rq'd for medium-voltage & some large/long low-voltage	Polywater or other vendor software		X	Consultant and Cont.	60, 90 and construction before pulling
Arc-flash	To label gear regarding arc-flash hazard and PPE required. CEC requires label, not calcs. Reference NFPA 70E and IEEE 1584	SKM PTW Arc Flash Evaluation		X	Consultant	90
Power factor correction	To size capacitors for single motor or systems.			X	Consultant	60 and 90
Battery/UPS sizing	To determine amp-hour based on load and duration.			X	Consultant	60 and 90
Transformer K-factor	To determine appropriate Kfactor for transformers with non-linear loads			X	Consultant	90, construction
VFD reflective wave	For motor distant from VFD			X	Consultant	90, construction
Lightning Protection Strike Distance	May be performance specified	Per NFPA 780		X	Consultant	60 and 90

[1] Suggested software/tools for use in Project
[2] Required conditionally. Required when applicable.
[3] Responsible party. Contractor provided calculations may require CA provided criteria

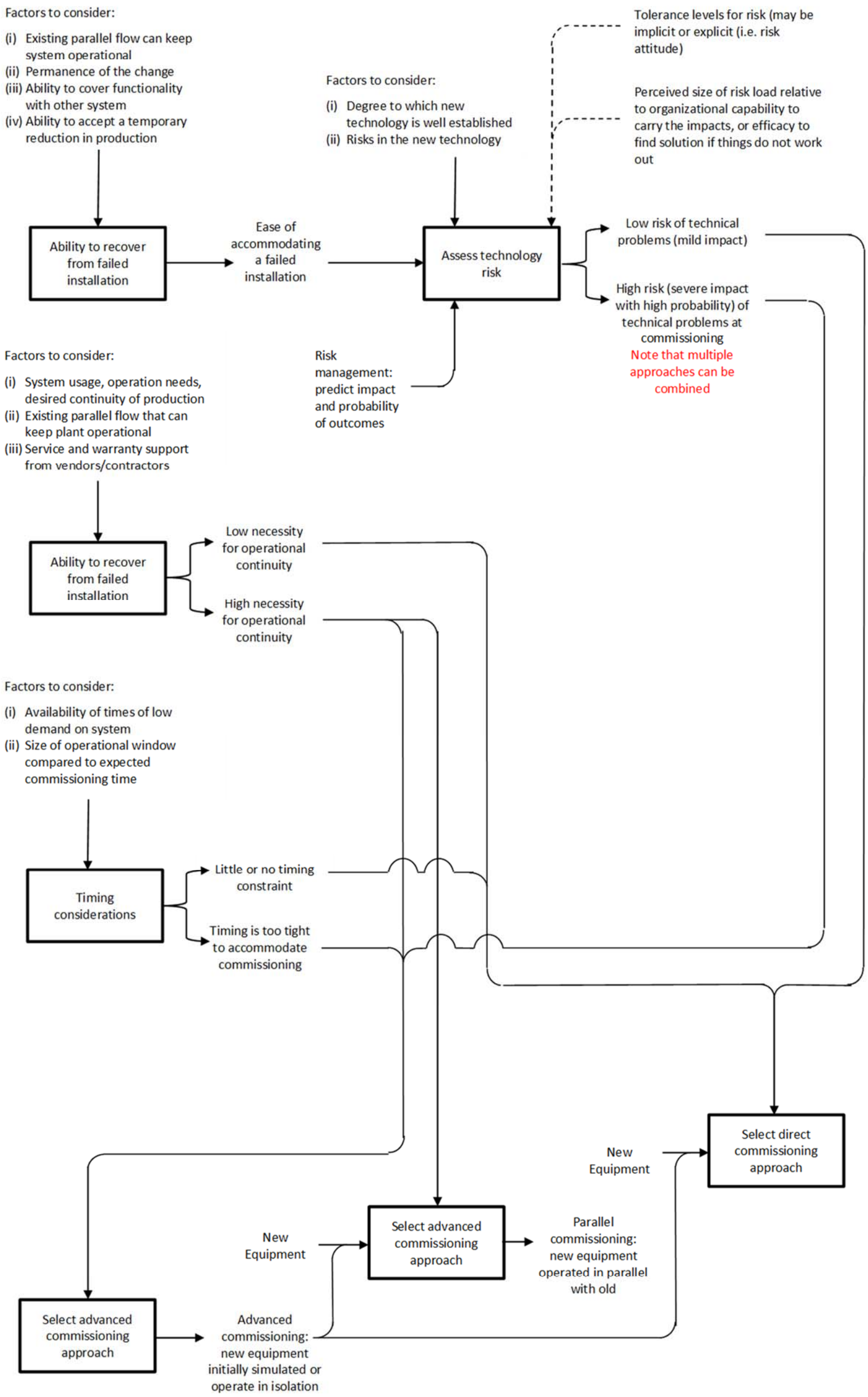
TABLE H-2 CALCULATIONS FOR MECHANICAL AND PROCESS DESIGN

Calculation	Description	Required Tools[1]	Always Req'd	Cond. Req'd[2]	Resp.[3]	Available for Review % Design Phase/ Const
Hydronic Pumps and Piping Systems	Pressure losses in the piping system and pump sizing requirements (e.g. power, NPSH, efficiency, etc.)	Pipe-Flow, spreadsheets or hand calcs using data from Crane Technical Paper 410 and ASHRAE Fundamentals	X		Consultant	30/60/90
Heat Exchangers	Heat loads per selected systems	Spreadsheets or hand calculations and vendor software	X		Consultant	30/60/90
Fluid Coolers	To size engine generator based on critical run and start loads.	Spreadsheets or hand calculations and vendor software	X		Consultant	30/60/90
Expansion Tanks	To determine appropriate expansion tank size	Hand or spreadsheet calculations using ASHRAE Fundamentals	X		Consultant	60 and 90
Pipe Insulation	To determine the thickness of pipe insulation to prevent condensation and/or personnel protection	3E Plus, equivalent hand or spreadsheet calculations	X		Consultant	60 and 90
Space Heating and Cooling Loads	Heating and cooling equipment sizing, air flow requirements, hydronic flow requirements	Carrier HAP, Trane Trace, equivalent hand or spreadsheet calculations using ASHRAE Fundamentals	X		Consultant	30/60/90
Ductwork and Air Distribution Systems	Pressure losses in the duct system and fan sizing requirements (power, efficiency, etc.)	Carrier HAP, Trane Trace, equivalent hand or spreadsheet calculations using ASHRAE Fundamentals and Duct Fitting Database	X		Consultant	30/60/90
Piping pressure classifications	Determine the appropriate pipe schedule based on materials used, fluid properties and corrosion allowance	ASME B31.9 methods using hand or spreadsheet calculations	X		Consultant	30/60/90

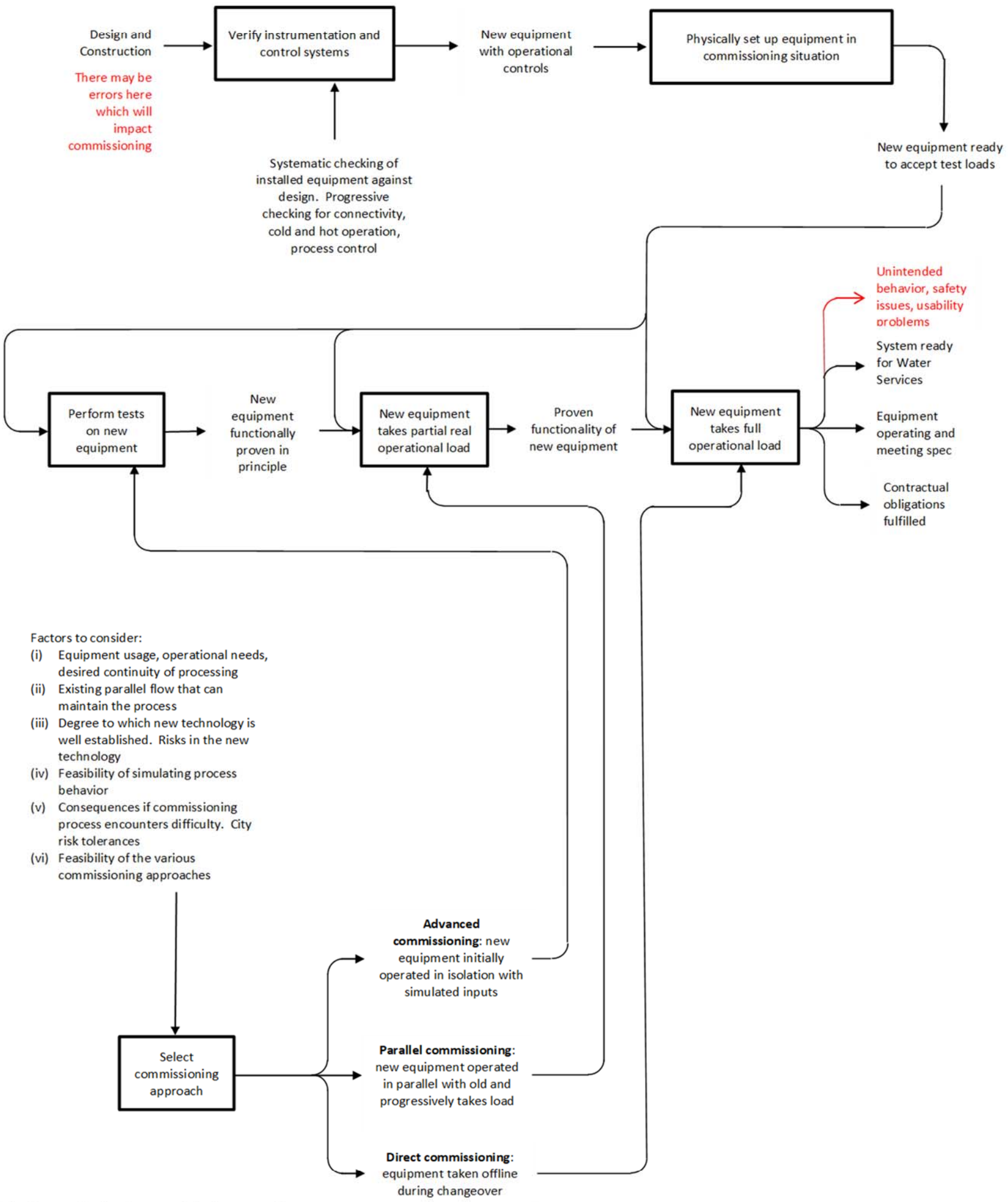
Calculation	Description	Required Tools[1]	Always Req'd	Cond. Req'd[2]	Resp.[3]	Available for Review % Design Phase/ Const
Natural or Propane Piping Sizing to End Devices	Determine the appropriate pipe size for gas or propane piping out to end devices from the main service or downstream of pressure regulators	CSA B149.1 – Natural Gas and Propane Code tables and equations. Hand calculations or spreadsheet	X		Consultant & Contractor	60, 90, and Const.
Potable Piping	Determine the appropriate pipe sizes for potable water systems within facilities	National Plumbing Code or acceptable spreadsheet calculations	X		Consultant	60 and 90
Drain Piping – Sanitary and Storm	Determine the appropriate pipe sizes for gravity drain systems within facilities	National Plumbing Code or acceptable spreadsheet calculations	X		Consultant & Contractor	60, 90, and Const.
Drain Vent Piping	Determine the appropriate pipe sizes for gravity drain systems within facilities	National Plumbing Code or acceptable spreadsheet calculations	X		Consultant & Contractor	60, 90, and Const.
Industrial Ventilation Requirements	Determine the air exchange rate, capture velocities and hood/ductwork design requirements for ventilation systems associated with hazardous chemicals	American Conference of Governmental Industrial Hygienists, Industrial Ventilation using hand or spreadsheet calculations	X		Consultant	30/60/60
General Ventilation Requirements	Determine the outside air and exhaust requirements for occupied spaces	ASHRAE 62.1	X		Consultant	30/60/90
Mass Balances	Chemical mass balances for dosing systems	Hand calculations or spreadsheets	X		Consultant	30/60/90

[1] Suggested software/tools for use in Project
[2] Responsible party. Contractor provided calculations may require CA provided criteria
[3] Required conditionally. Required when applicable.

APPENDIX I – COMMISSIONING APPROACH



APPENDIX J – COMMISSIONING STRATEGIES



Decision factors affecting the commissioning approach:

(i) **Advanced commissioning** is appropriate where technology risk is high, operational continuity is required, and timing constraints are tight.
(ii) **Parallel commissioning** is appropriate where operational continuity is required and timing constraints are tight.
(iii) **Direct commissioning** is appropriate where technology risk is low, operational continuity can be disrupted, and timing constraints are loose.

APPENDIX K – CITY OF WINNIPEG COVID-19 SELF-SCREENING QUESTIONAIRE

http://citynet/intrahom/covid-19/pdfs/cw-covid-19_screening_questionnaire.pdf

APPENDIX L – EQUIPMENT LIST SAMPLE

Equipment Tag	Description	Training Required	Lamacoid	Lamacoid Type	Submittals Required	Equipment Quantity	Drawing Number	Specification Section
			McPhillips Collection Building (0640B)					
CB-PNL-B10	250A 2P Circuit Breaker	No	Yes	D	Yes	1	E0001-001	26 05 53
DP-B701	600V Distribution Panel	No	Yes	A	Yes	1	E0001-001	26 07 80
HMI-G767	Human Machine Interface	Yes	Yes	D	Yes	1	E0013-001	29 08 41
MCC-G766	Motor Control Centre	Yes	Yes	A	Yes	1	E0006-001	26 07 80
CB-G767	125A 3P Circuit Breaker	No	Yes	D	Yes	1	E0006-001	26 07 80
LBD-G767	110kW Load Bank	Yes	Yes	A	Yes	1	E0007-001	26 21 13
			McPhillips Main Pumping Station "0640M"					
CHLR-M640	Main Pumphouse Air Cooled Chiller	Yes	Yes	A	Yes	1	M009-001	23 82 00
CDR-M640	Air Cooled Condenser	Yes	Yes	A	Yes	1	M009-001	23 82 00
P-M641	Chilled Glycol Circulation Pump - 11.2 kW	Yes	Yes	B	Yes	1	M009-001	23 21 23
P-M642	Chilled Glycol Circulation Pump – 11.2 kW	Yes	Yes	B	Yes	1	M009-001	23 21 23
TNK-M643	Chilled Glycol Expansion Tank	Yes	Yes	B	Yes	1	M009-001	23 82 00
AS-M644	Chilled Glycol Air Separator	No	Yes	B	Yes	1	M009-001	23 82 00
	NEMA 4x Exit Sign	No	No		Yes	4	E0042-002	

General Notes:

2. Not all equipment required for the Work is included I the list herein. This is a partial listing of main equipment only. Refer to the drawings and specifications for all equipment requirements.
3. Include all costs for the supply and complete installation of all equipment herein, and all equipment indicated on the drawings and in the specifications.
4. Include all costs for new lamacoids.
5. Include all costs for training.
6. Notwithstanding C2.4, in the event of discrepancies between this list and the drawings or specifications, the most onerous and costly option shall take precedence prior to clarification by the Contract Administrator.
7. Equipment quantities indicated include required spare components.

APPENDIX M – SUBMITTAL LIST SAMPLE

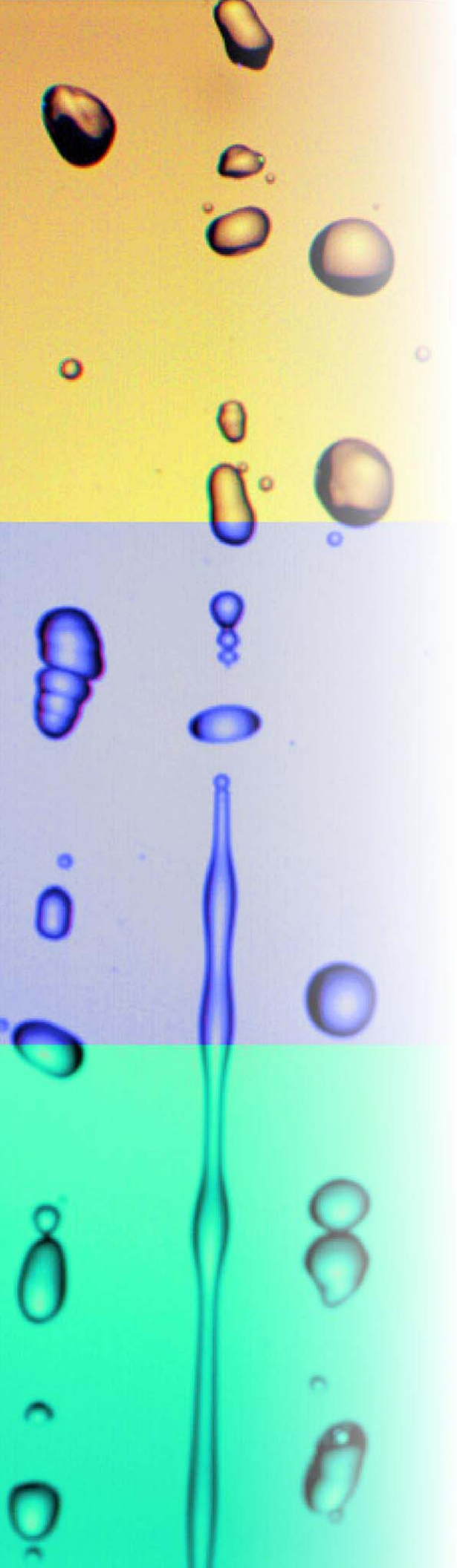
WORK PHASE	SUBMITTAL TYPE	SUBMITTALS FOR REVIEW	FOR INFORMATION	REFERENCE(S)	NOTES
Notices	Change in Insurance	No	Yes	D11.6	30 Calendar Days written notice
	COVID-19 Schedule Delays	No	Yes	D20.4	7 Calendar Days from becoming aware of delay.
	Hazardous Material	No	Yes	E2.1	Immediately
Commencement	Workers' Compensation Coverage	No	Yes	C6.17; D15.2(a)(ii)	Prior to commencement of Work
	Authority to Carry on Business	No	Yes	D9.1; D15.2(a)(i)	
	Safe Work Plan	Yes	No	D10.2	20 Business Days prior to commencement of Work on Site.
	Contract Security	No	Yes	D12.2	7 Calendar Days after notice of award.
	Certificate of Insurance	No	Yes	D11.5	2 Business Days prior to commencement of Work
	Subcontractor List	Yes	No	D13.1	
	Detailed Work Schedule	Yes	No	D14.1	
	Submittal Schedule	Yes	No	D14.7	
	Shop Drawings, Product Certifications, Product Data Sheets, Samples and Mock-ups, SDS	Yes	No	01 01 33	Prior to Work affected by Submittal, including review time
Mobilization and Demobilization	Site Condition's Report	Yes	No	E3.1.2; E3.2.2	Upon demobilization
	Construction Permits by Facility	No	Yes	C6.14	In accordance with AHJ requirements
	Site Laydown Plan	Yes	No	E3.2.3	10 Business Days prior to mobilization
Bi-Weekly Work Plan	Upcoming and Outstanding Submittals	Yes	No	E6.2(a)	Provide bi-weekly
	Updated detailed Work Schedule and Submittal Schedule	Yes	No	D14.9; E6.2(b); 01 33 00	
	City Forces Requirements	Yes	No		Within the next 28 Calendar Days
	Coordination of Work by Others	Yes	No		
	Planned Shutdowns and/or Commissioning	Yes	No		
	Planned training	Yes	No		
	Detailed description of select Work	Yes	No	E6.2(j)	Upon request
	Design revisions	Yes	No	E6.2(k)	As required
	Demolition schedule	Yes	No	E6.2(l); 01 736 00	14 Calendar Days prior to commencement of associated Work
	Asbestos abatement and disposal	Yes	No	E2; E6.2(m); 02 82 00.01	
Installation	Air Monitoring Results	Yes	No	02 82 00.01	Provide daily during asbestos abatement
	Field Quality Test Reports	Yes	No	Div 03; Div 23; Div 26	Prior to installation Work
	Lamacoid Namplate List	Yes	No	Div 23; Div 26	
	Site Acceptance Reports	Yes	No	01 98 00	During installation
	Manufacturer's Field Reports	Yes	No	Div 01	

WORK PHASE	SUBMITTAL TYPE	SUBMITTALS FOR REVIEW	FOR INFORMATION	REFERENCE(S)	NOTES
	Manufacture's Test Certificate	No	Yes	01 98 12	
	Loop Tests	Yes	No	29 05 00	
	Testing and Calibration	No	Yes	29 05 00	
Commissioning	Commissioning Plan by Facility	Yes	No	01 98 00	28 Calendar Days prior to scheduled commissioning start date
	Start-up Checklists by Facilitiy	Yes	No	01 98 00	
	Completed Start-up Checklist by Facility	Yes	No	01 98 00	5 Calendar Days prior to scheduled commissioning start date
	Commissioning Records by Facility	Yes	No	01 98 00	To be included in the Draft O&M Manual
	Request for City Certified Operator (off hours)	No	Yes	01 98 00	5 Business Days prior.
Training	Draft Training Plan by Facility	Yes	No	E11.2.2	42 Calendar Days prior to training
	Final Training Plan by Facility	Yes	No	E11.2.3	14 Calendar Days prior to training
	Training by Video by Facility	Yes	No	E11.2.5	21 Calendar Days following training session
Warranty Services	Contractor Information	No	Yes	C6.36	Prior to commissioning of the Facility
	Warranty Register	No	Yes	C6.36	28 Calendar Days to Facility Total Performance
Facility Closeout	Commissioning Records by Facility	Yes	No	01 98 00	14 Calendar Days to Facility closeout
	As-Built (red line) Drawings by Facility	Yes	No	01 78 00	
	Draft O&M Manuals by Facility	Yes	No	01 78 00	
Project Closeout	Final O&M Manuals	Yes	No	E13.2.2(b)(ii)	28 Calendar Days prior to Final Substantial Performance

General Notes:

1. The Submittal List is intended to be provide a summary of the Contract submittals noted throughout the Contract Documents. However, the Submittal List is for information purposes only and the Contractor shall be responsible to conform to the requirements of the Contract Documents.
2. For clarity the Submittal List does not capture any documentation or submittals required to be submitted by the Bidder in accordance with Part B – Bidding Procedures of the Tender.

APPENDIX N – DESIGN BASIS MEMORANDUM SAMPLE



Winnipeg

THE CITY OF WINNIPEG WATER TREATMENT PLANT

Design Basis Memorandum Draft

Project No. 79538–02

April 26, 2005

CH2MHILL

EarthTech
A Tyco International Ltd. Company

uma

Frederickson Cooper
ARCHITECTS

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GENERAL

PROJECT TITLE:	Winnipeg Water Treatment Program Design Consultant Services
PROJECT NUMBER:	79538
PROJECT MANAGERS:	Doug Taniguchi, P. Eng. Albert Li, P. Eng. Ray Bilevicius, P. Eng.
DISCIPLINE LEADS:	
CIVIL/SITE:	Jeff Crang, P. Eng.
BUILDING MECHANICAL (HVAC):	Alan Aftanas, P. Eng.
ELECTRICAL:	Petr Stryk, P. Eng.
INSTRUMENTATION & CONTROLS:	Stephen Tormey, P. Eng.
HEAVY STRUCTURAL:	Melvin Klassen, P. Eng.
BUILDING STRUCTURAL:	Dino Kruger, P. Eng.
ARCHITECTURAL:	Bryan Shaw
PROCESS MECHANICAL:	Paul Wobma, P. Eng.
REVISION:	**B**
DATE:	**April 19, 2005**

CLIENT: City of Winnipeg, Water & Waste Department

LOCATION: Deacon Site, Winnipeg, Manitoba
Adjacent to the existing Deacon Booster Pumping Station.

PROJECT SCOPE: The scope of the work includes the detailed design of the Winnipeg Water Treatment Plant and includes the following plant areas:

Civil/Site: Includes site work, utilities, demolition, access, roads, railway, landscaping, grading, paving & construction, and staging.

Electrical Substation: Design details & information related to electrical substation.

Yard Piping: New yard piping, demolition & yard piping valve chambers and connections.

Main Water Treatment Plant: The main water treatment building incorporates administration component as well as the Raw Water Pumping station and will involve Architecture, Process and Building Mechanical, Electrical, and Instrumentation & Controls. The main plant includes process areas: for DAF and Flocculation, Filtration, Ozonation, Residuals, and Chemical dosing.

Bulk Chemical Storage Building: Architecture, Structural, Building Mechanical, Electrical, Instrumentation & Controls. The Bulk Chemical Storage building is situated to the north of the Main Water Treatment Building. The Aqua-ammonia storage and feed equipment room will be housed inside the Bulk Chemical Storage Building.

Residuals Management: Refers to the freeze-thaw lagoons, associated forcemain and pump station including Structural Building Mechanical, Process Mechanical, Electrical, and Instrumentation & Controls.

Deacon Booster Pumping Station: Modifications to the existing station to receive new pumps, and involves Structural, Process Mechanical, Electrical, and Instrumentation & Controls.

Clearwell: Buried concrete structure for treated water storage including two above grade buildings housed over the inlet and outlet (respectively) portions of the clearwell. Involves Architecture, Structural, Building Mechanical, Process Mechanical, Electrical, Instrumentation & Control.

On-Site Hypochlorite Generation Building: Onsite Hypochlorite Generation Building. is a stand alone building west of the Bulk Chemical Storage Building complete with a outside Transformer Pads on the west side for the 600V Electrical supply to both chemical buildings).

Standby Generator Building: Above-grade facility housing the standby generators, situated to the north of the proposed Water Treatment Plant Building.

The Design Consultant project deliverables include tender-ready drawings and specifications adequate information to enable the Construction Manager (on behalf of the City of Winnipeg) to obtain competitive bids from qualified contractors for the supply and erection of the plant areas and equipment.

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN BASIS		• During Construction: -35°C to 35°C • Ambient: -35°C to 35°C • Ambient Interior: Refer to each plant area
	SYSTEM OF MEASUREMENT		The accepted system of measurement will be the SI system.

CIVIL/SITEWORKS

DISCIPLINE LEAD STRUCTURAL:	Jeff Crang, P. Eng.
ROAD AND RAIL DESIGN:	Jeff Crang, P. Eng.
HYDRAULIC DESIGN:	Devon Danielson, P. Eng.
MUNICIPAL DESIGN:	Greg Karman, C.E.T.
QA AND REVIEW:	Todd Smith, P. Eng. (Roads), Mike Eggleston, P. Eng. (Rail), Hydraulics?, Municipal?

INTRODUCTION:

The following siteworks design brief for the Winnipeg Water Treatment Plant is based on the scope of work identified in the proposal document and currently referenced in the project plan. This design basis document provides design basis for transportation, municipal and hydraulic aspects for the Winnipeg Water Treatment Plant. Variations, special considerations for specific plant areas shall be identified and appended to this document.

SCOPE AND DESCRIPTION OF CIVIL/SITEWORKS:

The civil/siteworks engineer will provide detailed design for all proposed roads, rail, parking lot and site drainage, as presented in the Preliminary Design Report.

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REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN BASIS	Main Access Road and Truck Loop Service Roads Parking Lot Railway Drainage	
	SYSTEM OF MEASUREMENT	Roadway and Drainage Railway	• Metric • Imperial
	DESIGN REFERENCES (Latest Editions)	Roads	• City of Winnipeg – Transportation Standards Manual • Transportation Association of Canada – Geometric Design Guide for Canadian Roads • Manitoba Transportation and Government Services – Warrants and Standards for Intersection Treatments of Rural Two-Lane Highways • Manitoba Transportation and Government Services –Transportation Planning Manual Manitoba Transportation and Government Services – Highway Design Manual
		Rail	• American Railway Engineering and Maintenance-of-Way Association – Manual for Railway Engineering
REV	**CATEGORIES**	**ITEMS**	**DESCRIPTION**
	DESIGN PARAMETERS - ROADS	Classification Design Speed Design Vehicle Lane and Shoulder Widths Minimum Stopping Site Distance	• Highway No. 207: Collector • Main Access Road: Local Industrial Street • Highway No. 207 = 120 km/h • Main Access Road = 60 km/h • Truck Loop and Service Roads = 40 km/h • WB-20 TAC Tractor Trailer Combination • PTAC (service roads only) • Highway No. 207 – as shown on Drawing No. WM-C007P • Main Access Road 3.75 m lanes, 0.75 m shoulders or curb and gutter • Truck Loop = 3.75 m lanes, 1.5 m shoulders or curb and gutter • Service Roads = 3.0 m lanes, no shoulders • Highway No. 207 = 260 m • Main Access Road = 90 m • Service Roads = 45 m

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN PARAMETERS - ROADS (Continued)	Intersection Sight Triangles	Highway No. 207: 450 m at 3 m from edge of roadway
		Vertical Curvature	**CREST CURVE (K)** • Highway No. 207 = 170 • Main Access Road = 20 • Internal Service Roads = 5 **SAG CURVE (K)** • Highway No. 207 = 30 • Main Access Road = 10 • Internal Service Roads = 4
		Horizontal Curvature	• Desirable Radius = 100 m • Minimum Radius = WB-20 turning movement
		Minimum Access Spacing	• Highway No. 207: 200 m to 600 m • Main Access Road: 60 m
		Gradient	• Maximum = 3% • Minimum = 0.5 % Note: A vertical curve is implemented if the following criteria are met: • Crest = 0.8% minimum • Sag = 1.5% minimum
		Height of Embankment (D)	• D = 1.2 m desirable, 0.8 m minimum Note: It is good practice to keep the centreline profile above prairie by 0.8 m
		Sideslope	• All Roads = 4:1
		Backslope	• All Roads = 4:1 up to 2 m cut, 3:1 over 2 m cut
		Cross Fall	• Gravel Surface = 3.5% • Concrete or Asphalt Surface = 2% • Gravel Shoulders = 4%
		Ditch Width	• Swale ditch minimum, 3.0 m desirable
		Sidewalk	• 2.0 m, 2% crossfall, ramp curb for accessibility at Administration Building
		Ditch Grades	• Desirable = 0.3% - 0.5% • Minimum = 0.1%
		Utility Locations	• City standard is to keep communications on the south side of the Main Access Road and electricity and gas on the north side. This standard may be waived due to site constraints.
		Curb and Gutter	• A City mountable curb is preferred.
		Parking Lot	• Slope = 1% - 4% • Stall Width = 2.7 m, 3.0 m handicapped • Stall Length = 6.0 m

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN PARAMETERS - RAIL	Gradients and Curvature	• Curvature will not exceed 12 degrees
		Subgrade and Ditches	• Subgrade top width is 24 feet, with 2:1 sideslopes • 8 feet side ditches will be provided as necessary to ensure natural drainage and runoff is maintained
		Culverts	• Culverts will be installed as necessary to maintain natural flows across the right-of-way and would generally be galvanized corrugated metal pipe, designed to meet the 1 in 100 year flood event.
		Sub-ballast	• A minimum of 6 inches (crushed or screened pit run gravel, containing no more than 3% organics by weight) used to below the ballast to distribute the load of the train to subgrade.
		Ballast	• 6 inches of crushed rock ballast under the tie (CN Industrial Specification used throughout.
		Track Structure	• Rail – 100 lb jointed PW (partly worn) (controlled cooled for dangerous commodities • Tie Plates – 7 ½ " x 11" PW • Rail Anchors – Improved Fair • Spikes – 5 ½ " long, minimum two per tie plate, new • Joint Bars – minimum four holes • Ties – 6" x 8" x8'-0", #2 treated softwood new or rehab, 2840 per mile • Turnouts –#8, 100 lb. on GWWD Railway. New ties for all turnouts
	CONSTRUCTABLILITY CONCERNS		•

REV	CATEGORIES	ITEMS	DESCRIPTION
	CONSTRUCTION & DESIGN FEATURES	Ground Water Soil Unloading Docks Future Expansion Site Constrained Site Drainage A-Section Main Aqueduct Spring Weight Restrictions Parking Intersection of Highway No. 207 & Main Access Road Emergency Site Access Roadway Lighting East of WTP Drainage Siding Diversion Hydro Transmission Tower Freeze-Thaw Lagoon Access	• Varies greatly (Spring conditions, floodway operation, holdings cells) • Highly plastic clays over till layer on limestone bedrock • Reinforced concrete pads with spill containment are required at all unloading areas. Unloading pads must be located no further than 6 m from the Camlock. • Road configuration should allow for the building envelope required for a 200 ML/day expansion • Consideration will have to be given to proper road and drainage design in light of the space constraints • Due to the small size of the sight, catchbasins will be used in lieu of ditches • Due to the inadequacy of the aqueduct loading protection will be required. This will be provided with a bridge similar to ones used in the past. • The design engineer will be required to make an application to Manitoba Transportation to have the weight restriction on Highway No. 207 waived during periods of restriction. • The current requirement for parking spots is approximately 25. • It has been determined that the intersection accessing the plant will be required to be widened. • The City wants an emergency access to incorporate into the road design. • Intersection lighting is not required • The site east of the WTP should be re-graded and drained through the tracks, approximately 75 m east of the bulk chemical building. • To make space for the rail car shed adjoining the bulk chemical building the current siding must be moved “south” approximately 1.5 m. • The hydro tower located approximately 500 m west of Highway NO. 207 is required to be moved due to interference with the WTP. Currently it is proposed to relocate this tower approximately 35 m southwest of its current location. • An access will have to be determined for the lagoon. •

REV	CATEGORIES	ITEMS	DESCRIPTION
	SCHEDULING	Bulk Excavation Finalize Preliminary Design Chemical Railway Spur Design Site Utility Design Roads and Parking Lot Design Landscaping and Fencing Design	• January – February 2005 • March 2005 • January 2, 2006 – March 31, 2006 • May 2, 2005 – September 29, 2006 • September 1, 2006 – November 23, 2006 • September 1, 2006 – November 23, 2006
	SPECIFICATIONS	City of Winnipeg Roads Manitoba Transportation Roads	• City of Winnipeg – Standard Construction Specifications • Manitoba Transportation – Standard Construction Specifications
	DRAWINGS	List Standards	• See Master List • See Appendix L of QMP

ARCHITECTURAL

DISCIPLINE LEAD ARCHITECTURAL: Bryan Shaw

ARCHITECT: Neil Cooper, B.E.S., M,Arch, M.A.A.

QA AND REVIEW:

INTRODUCTION: The architectural scope of work includes provisions for code review with respect to exiting, occupancy, and use. Detailing and specifying of the doors, hardware, and all finishes (excluding floor). The architect will also provide design input to the exterior building aesthetic. Special attention will be paid to the building envelope including roof and wall systems. The architect will also provide input to the schematic planning and space programming.

SCOPE AND DESCRIPTION OF STRUCTURE: Landscape architecture will incorporate low-maintenance vegetation as much as possible.

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN CODES (Latest Editions)	General	• National Building Code of Canada (NBCC) • National Model Energy Code • Supplement to the NBCC
	DESIGN PARAMETERS	Design Temperature Range	• During Construction: -35°C to 35°C • Ambient: -35°C to 35°C
	SPECIAL REQUIREMENTS	Handicap Access	• Provide Administration Building with barrier-free access. The remainder of the plant will not be provided with universal access.
	BUILDING ASSEMBLY	Substructure	• Concrete
		Foundations	• Piling
		Floors	• Concrete
		Walls	• Exterior walls • Masonry enclosures around the electrical generator and auxiliary rooms to underside of the roof • Thermal insulating values of completed wall assemblies to conform to Model National Energy Code • Exterior aesthetic
		Roof	• 2 ply modified bituminous roofing or EPDM roofing system? • Roof parapets
	EXPANSION JOINTS		• Due to the large size of the main water treatment plant roof and wall expansion joints will be incorporated where required.
	OTHER SPECIAL FEATURES (i.e., mech, arch, etc.)	Overhead Doors	• Insulated, roll-up or section doors, electrically operated, sizes to be determined
		Walls	•
		Man Doors	• Insulated, 16 gauge galvanized steel, 45 mm thick. • Heavy duty, corrosion-resistant hardware.
		Interior Doors	• Insulated, hollow steel, painted, 600 mm2 tempered glass lights in upper half except in washroom doors. • Heavy duty, corrosion-resistant hardware.
		Insulation	• Non-combustible and designed so that the completed wall assembly has an insulating value which meets the recommendations of the model National Energy Code for Buildings

REV	CATEGORIES	ITEMS	DESCRIPTION
	OTHER SPECIAL FEATURES (i.e., mech, arch, etc.) (Continued)	Roof	• Maintenance access hatches are required at each roof level; a minimum of 2 for an area of 800 m^2 • Traveled pathways shall be protected by concrete pavers • Insulated membrane roofing system comprised of 2 ply modified bitumen roofing or an optional mechanically fastened EPDM roofing on galvanized steel decking.
	SCHEDULING		•
	UNRESOLVED MAJOR ITEMS		• Building aesthetic • Administration building program, require staffing compliment and review of program requirements to establish final space data and plan.
	SPECIFICATIONS		• City of Winnipeg accepted format
	DRAWINGS	List	• See master list
		Standards	• Refer to Appendix L of QMP
A		Geodetic Elevation	•

STRUCTURAL

DISCIPLINE LEAD STRUCTURAL: Mel Klassen, P. Eng. – ETC
Dino Kruger, P. Eng. – CH2M Hill

STRUCTURAL DESIGN: Fred Kemp, P. Eng./Rados Eric – ETC
Gabe Profeta – ETC
- CH2M Hill

QA AND REVIEW: Ian Shrimpton, P. Eng. – ETC
Kem McWhinnie- CH2M Hill

INTRODUCTION:

The following structural design brief for the Winnipeg Water Treatment Plant (WWTP) is based on the scope of work identified in the proposal document and currently referenced in the project plan. This design basis document provides design basis of Electrical Substation, and other ancillary structures (transformer pads, lagoon dewatering pump station, inlet and outlet distribution chambers).r general structural aspects for the Winnipeg Water Treatment Plant. Variations, special considerations for specific plant areas are identified and appended to this document.

SCOPE AND DESCRIPTION OF STRUCTURE:

The WWTP structures consist of the Water Treatment Plant, Clearwell, Bulk Chemical Storage Building, Generator Building, Yard Piping Valve Chambers, Electrical Substation, and other ancillary structures (transformer pads, lagoon dewatering pump station, inlet and outlet distribution chambers).

The soil conditions as such that precast concrete piles foundations will be used for most of the structures. The predominant construction material for the substructures will be cast-in-place concrete. The superstructures will be a combination of cast-in-place concrete, concrete masonry, precast concrete, and steel.

Engineering responsibility will be generally as follows:

- Water Treatment Plant (including Main WTP, Raw Water Pumping Station, Administration Building, Enclosed Bridge, Residuals Treatment Area) – CH2M Hill.
- Clearwell, Bulk Chemical Storage Building, Generator Building, Electrical Substation, and other ancillary structures (transformer pads, lagoon dewatering pump station, inlet and outlet distribution chambers) -= ET.
- Yard Piping Valve Chambers – UMA.

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN BASIS	Soil/Pile Foundation	• Working Stress Design
		Water retaining structure	• ACI 350 (Strength Design Method)
		Non-water retaining Structure	• Limit States Design (steel, concrete, and masonry)
		Climatic	• NBCC 1995 and Supplement
	DESIGN CODES (Latest Editions unless noted otherwise)	General	• National Building Code of Canada 1995 (NBCC) and referenced standards therein • Supplement to the NBCC • National Fire Code of Canada • The Workplace Safety and Health Act • National Sanitation Foundation 61 Standards • Occupational Health and Safety Act and Regulations for Construction Projects
		Cast-in-Place Concrete	CSA Standards: • CSA A23.1-00 Concrete Materials and Methods of Concrete Construction. • CSA A23.2-00 Methods of Test for Concrete • CSA A23.3-94 Design of Concrete Structures (Structures Design) • CSA A23.4-00 Precast Concrete – Materials and Construction • CSA A3001-03, Cementitious Materials for Use in Concrete ACI Standards: • ACI 350 Environmental Engineering Concrete Structures. Design Aids: • "Rectangular Concrete Tanks" 5th edition, Portland Cement Association • Concrete Reinforcing Steel Institute Handbook. CISC Handbook of Steel Construction (7th Edition - 2000)
		Pre-cast Concrete	CSA Standards: • CSA A23.4-00 Precast Concrete – Materials and Construction Design Aids: • "PCI Design Handbook Precast/Prestress Concrete" fourth edition
		Masonry	• CSA-A179 – Mortar and Grout for Unit Masonry • CSA-S304 – Masonry Design for Buildings (Limit States Design) • CSA-A370 – Connectors for Masonry • CSA-A371 – Masonry Construction for Buildings

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN CODES (Latest Editions unless noted otherwise) (Continued)	Wood	• CSA O86-01 – Engineering Design in Wood
		Structural Steel	CSA Standards: • CAN/CSA-S16.1-94 – Limit States Design for Design Structures • CAN/CSA-G40.20 – General Requirements for Rolled or Welded Structural Quality Steels • CAN/CSA-G40.21 – Structural Quality Steels • W47.1 – Certification of Companies for Fusion Welding of Steel Structures • W59 – Welded Steel Construction (Metal Arc Welding) ASTM Standards: • A307 – Specification for Carbon Steel Bolts and Studs • A325 – Specification for High Strength Bolts for Structural Steel Joints • CISC Code of Standard Practice for Structural Steel CISC Handbook of Steel Construction (7th Edition)
		Aluminum	• CSA CAN3-S157.M83 (R2002) – Strength Design in Aluminum
	DESIGN REFERENCES	Cranes	• B167-96 – Safety Standard for maintenance and inspection of overhead cranes, gantry cranes, Monorails, hoists, and trolleys
	DESIGN PARAMETERS	Ground Snow and Rain	• S_s=1.7 kPa • S_r=0.2 kPa
		Wind	• q(1/10)= 0.35 kPa • q(1/30)= 0.42 kPa • q(1/100)= 0.49 kPa
		Seismic	• Z_a=0 • Z_v=0 • Zonal Velocity ratio=0
		Design Temperature Range	• During Construction: -35°C to 35°C • Ambient: -35°C to 35°C
		Design Live Loads	• Electrical and Mechanical Equipment Rooms – equipment weight, but not less than 14.4 kPa plus 9.0 kN point load; loading less than this to be reviewed by associated disciplines. • All equipment loads are to be based on certified data supplied by the equipment manufacturer and will include self-weight and any added items (piping, liquids, curbs, etc.) and impact forces. Operating weight of equipment will be specified on certified shop drawings.

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN PARAMETERS (Continued)		• Cranes: overhead bridge cranes, monorails and hoists, jib cranes, etc., design loads to be determined on an individual basis • General personnel areas: 4.8 kPa • Stairs and walkways: 4.89 kPa • Basic roof loads: 1.0 kPa • Minimum lateral interior walls: 0.25 kPa • Truck: to be determined on an individual basis, reference CAN/CSA-S6-00, CL-625 Truck (N.B. 62.5 tonne). Concrete truck: 32 tonnes on 4 axles with 8 tonnes each. • Loading restrictions as applicable are identified in the appended descriptions for each structure.
		Lateral Earth Loads	• **Note:** *Refer to geotechnical portion of PDR.* • Pressures due to backfilling at top 2m: 20 kN/m^2 to account for backfilling operations
		Dead Loads	• Concrete: 23.6 kN/m^3 • Steel: 77 kN/m^3 • Aluminum: 25.9 kN/m^3 • *Masonry • *Roofing • *Wall cladding *If not listed use unit weights of construction materials and systems obtained from the appropriate Design Handbook.
	LOAD FACTORS (ACI 350 – Strength Design Method)	Dead Load	• 1.4
		Live Load	• 1.7
		Environmental	• 1.3
	LOAD FACTORS (Limit States)	Dead Load	• 1.25
		Live Load	• 1.5
		Crane Impact	• Per NBCC – 1.25 (powered), 1.10 (manual) • Normal to rails: 20% of weight of lifted load plus crane trolley for powered • Parallel to rails: ≥ 10% of maximum wheel loads for powered • Design references provide more detailed design guidance
		Wind	• 1.5
		Temperature	• 1.25
		Buoyancy, Overturning	• 0.85 for dead loads, 1.5 for live loads

REV	CATEGORIES	ITEMS	DESCRIPTION
	LOAD FACTORS (Limit States) (Continued)	Combination	• 1.0 for any single load • 0.7 for 2 of live, wind, and temperature • 0.6 for all live, wind, and temperature
	LOADS SUPPLIED TO OTHERS		• As required
	SERVICE REQUIREMENTS	Deflection Criteria (live load)	• Floors plates and grating – L/240 or 6 mm maximum • Platforms and walkways – L/240 • Roof structures – L/360 • Floor structures – L/360 • Supports for masonry – L/600 or 6 mm maximum • Monorail and bridge crane supports – L/800
	BUILDING ASSEMBLY	Substructure	• Generally all elements to be reinforced cast-in-place concrete

		Foundations	• Precast concrete hex piles
			  ○ 350 Diameter – 625 kN
			  ○ 400 Diameter – 800 kN

		Floors	• Generally to be reinforced cast-in-place concrete
		Walls	• Requires project Architect input • Generally to be reinforced cast-in-place concrete or reinforced concrete masonry

		Roof	• Requires project Architect input
			• Options:
			  ○ Cast-in-place concrete
			  ○ Precast concrete – double tees, hollowcore
			  ○ Truss/OWSJ/steel deck

	STRUCTURE STABILITY	Structural	• Horizontal and lateral loads will be handled by concrete or masonry shear walls • Roof diaphragm • Cross Bracing for steel structures

REV	CATEGORIES	ITEMS	DESCRIPTION
	CONCRETE WORK	Design parameters	• 28-day concrete strength of 35 MPa for all water retaining structural concrete; other concrete as appropriate for type of usage. • Portland cement type 50 (HS) will be used for concrete in contact with native soil and for water retaining structures. • Portland cement type 10 (GU) will be used for concrete not in contact with native soil. • Water to cement ratio shall be less than 0.42 for all structures. • Reinforcing bars will be specified to conform to CAN/CSA-G30.18-M92.
		Concepts	• Liquid retaining structures shall be designed by working or ultimate design method. See ACI 350. for load factors, allowable stresses, and crack control • Remaining structures shall be designed using CSA A23.3-94 (limit states). • Special consideration for concrete exposed to water of pH levels as listed below: o For pH above 6.5 – use form liner o For pH 6.3 to 6.5 – use form liner and silica fume in concrete mix o For pH below 6.3 – protective coating **NOTE: Process input required for anticipated pH levels for all areas* • Special considerations for concrete exposed to ozone are outlined for the specific structures appended to this document **NOTE: Process input required for anticipated ozone contact areas.* • Special considerations for concrete exposed to corrosive chemicals are outlined for the specific structures appended to this document **NOTE: Process input required for anticipated type of corrosive chemicals and areas affected by these chemicals* • Crack control and shrinkage resistance measures shall be employed: o W/C 0.42 or less o Aggregates coarse, well rounded, well graded, size to ASTM C33 (Do we have this publication?) o Require test batch with laboratory 21- or 28-day drying age results 0.039% or 0.045% respectively o Meet minimum design strength • All water retaining structures will be required to be tested for watertightness per ACI 350.1.

REV	CATEGORIES	ITEMS	DESCRIPTION
	CONCRETE WORK (Continued)	Detailing Concepts	• Walls over 3 meters high should not be less than 300 mm thick. • Walls less than 250 mm thick are to be detailed with a single layer of reinforcing steel. • Walls 250 mm or thicker shall be detailed using two layers of reinforcing steel. • Slabs less than 200 mm thick are to be detailed with a single layer of reinforcing steel. • Slabs 200 mm or thicker shall be detailed using two layers of reinforcing steel. • Water retaining structures - maximum stresses for steel reinforcing and minimum reinforcing per to conform to ACI 318 and ACI 350.
		Concrete Finishes	• Concrete finishes and type of forming will be coordinated with the architectural room finish schedules • Exposed exterior formed concrete or formed concrete to receive coatings shall have a smooth-form finish. Other exterior concrete to receive rough-form finish. • Exposed interior formed concrete shall have a smooth-rubbed finish. Other interior concrete to receive smooth-formed finish. • Water retaining interior formed concrete walls to receive formliner surface.
		Expansion and Construction Joints	• Expansion joint locations will be determined by the engineer and shall consider shape and behaviour of the structure resulting from shrinkage, temperature changes, and foundation conditions • Maximum expansion joint spacing to be 30 m; however, greater spacing may be achieved with adequate reinforcing spacing • Construction and control joints locations may be suggested on the drawings; however, the contractor may have input into the locations to suit his construction methods, but must be reviewed by the engineer • Maximum spacing of construction and control joints shall be +/-14 m • Provide waterstop in wall and slab expansion and construction joints separating dry areas from earth or liquid, in exterior walls and slabs of liquid holding tanks • PVC waterstop minimum widths to be 150 mm for construction and control joints and 225 mm for expansion joints • Stainless steel waterstop will be used for ozone contact areas.

REV	CATEGORIES	ITEMS	DESCRIPTION
	STRUCTURAL PRECAST CONCRETE	Design Concepts	• Precast manufacturer shall be responsible for structural design of individual precast prestressed components, connections between components, and components connections to cast-in-place concrete. • Design, reinforce, and prestress units as required by CSA A23.4, and PCI Design Handbook. • There shall be no tension under superimposed live load of 0.72 kPa in bottom of precast units used over water holding structures. • Provide minimum of 38 mm of cover for tendons in precast units when located over water.
	MASONRY	Design Concepts	• Design based on CSA S304.1 Masonry Design for Buildings. • Construction and design shall meet the requirements of CSA A371. • Masonry walls shall be laid in a running bond pattern. • Masonry walls shall be used as bearing and shear walls for the structures as required. • Space control joints at two times the height of wall, but not more than 7.6 meters. • Provide joint reinforcement at 400 mm on centers. • Provide structural bond beams at connections to roof and floor diaphragms and at top of walls. Bond beams minimum reinforcement of 2-15M bars. • Provide minimum vertical reinforcement in the masonry wall of one 15M bar at 600 mm on center. Additional bars to be provided as required by structural analysis, at all corners, wall intersections, and at edges of all openings. • Masonry unit cores with bars shall be solid grouted.
		Material	• Block to CSA A165 Series, H/15/A/M. • Mortar and grout to CSA A179.

REV	CATEGORIES	ITEMS	DESCRIPTION
	METAL DECKING	Design and Detailing	• Shall conform to the requirements of CSA S136 with reference to the "Steel Deck Institute (SDI) Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution". • Roofs to perform as diaphragms shall conform to the requirements of "SDI Diaphragm Design Manual". • Deck shall be designed to generally span over three supports wherever possible. • No permanent loads shall be suspended from roof deck. • Decking shall have a minimum bearing length of 38 mm at supports. • Drawings shall include deck type, thickness in mm or gauge, minimum moment of inertia, minimum section modulus, depth and fastening requirements.
		Material	• Steel used in decks shall have a minimum yield strength of 228 MPa. • Maximum working stress under full live and dead loads is not to exceed 138 MPa. • Steel decks shall be galvanized to ASTM A446. • Roof deck shall be a minimum of 0.76 mm thick.
	STEEL JOISTS	Design and Detailing	• Shall conform to the requirements of the CSA S16.1, CSA S136, Canadian Institute of Steel Construction, (CISC) "Code of Standard Practice for Buildings" and "Steel Joist Facts". • The effects of ponding shall be investigated. • Span of steel joist shall not exceed 24 times its depth. • Size and spacing of joists should be kept uniform whenever possible. If loading increases, maintain the same size joist and reduce spacing. • Drawings shall show required joist, or joist girder, designation, spacing, bridging, and applied live load. • Concentrated loads and specified area loads due to equipment shall be noted on the drawings. • Effects of wind uplift shall be considered for joists supporting roofs. • Joists are to be designed by a registered Professional Structural Engineer registered in the Province of Manitoba.

REV	CATEGORIES	ITEMS	DESCRIPTION
	METALS	Connections	• Generally design loading shall be provided on the drawings for the fabricator to design the connections. However, where loads are not specified the fabricator will be designing connections to minimums as per specifications o Shear – 60% of beam shear resistance o Bracing – 50% of member tensile resistance o Connection bolts for metal-to-metal connections shall be to ASTM A325 for steel members; to ASTM A325 galvanized or stainless steel for galvanized steel members; and stainless steel for aluminum or stainless steel members. Minimum of two bolts per connections. Cast-in-placed anchor bolts or concrete adhesive anchors shall be used for dynamic loading or anchors close to concrete edges.
		Floor and Plate Grating	• Floor plates and grating generally to be constructed of aluminum. • Design floor plates and grating for same live load as floor. Limit deflection to the lesser of L/240 or 6 mm under design load of 4.8 kPa. • Floor plates shall have raised checker pattern or be grit surface.
		Stairs	• Stairs generally to be constructed of aluminum. • Stairs and landings shall be designed to support dead loads and a uniform live load of 4.8 kPa or a concentrated moving load of 4.5 kN. • Stringers should be 300 mm minimum depth channel or tubes to allow for installation of prefabricated treads. Smaller sections may be used for ships ladders.
		Ladders	• Ladders generally to be constructed of aluminum. • Ladder rungs shall be designed to support a 1.3 kN concentrated load applied in any direction. • Each pair of ladder support brackets shall be designed to support a 2.2 kN vertical load combined with a 2.2 kN pullout load. • Provide safety cage or climbing device when required by OSHA or owner safety requirements.
		Grating Support	• Design to support applied loads. Deflection of support shall not exceed the lesser of 12 mm or L/360. • Steel members supporting aluminum grating shall be stainless steel or hot dip galvanized. • Minimum thickness of support member at wet or exterior locations shall be 6 mm.

REV	CATEGORIES	ITEMS	DESCRIPTION

	METALS (Continued)	Materials	• Structural steel - CSA G40.21, minimum 350 MPa
			• Miscellaneous steel - CSA G40.21, minimum 300 MPa
			• Round structural tubing and steel pipe - ASTM A53, grade 240, Type S, Grade B, standard wall thickness
			• Square and Rectangular Hollow Structural Shapes - CSA G40.21, minimum 350 MPa
			• Stainless Steel
			  o Exterior, submerged, and industrial uses - ISI, Type 316
			  o Interior and architectural use - AISI, Type 304
			  o Bolts and anchors - AISI, Type 304
			• Aluminum, structural shapes and plates - Alloy 6061-T6 or 6351-T6
			• Bolted connections for steel - ASTM A325
			• Anchor bolts, submerged - Stainless steel
			• Anchor bolts, non-submerged - Galvanized steel
			• Connection bolts for aluminum - Stainless steel
			• Guardrail – Aluminum
			• Grating - Aluminum or galvanized steel
			• Generally, City preference for miscellaneous items is aluminum or stainless steel versus FRP materials

	VIBRATIONS		• To avoid resonance, the natural frequency of the structure should be either less than half or greater than one and a half of the frequency of the machinery • Where possible, provide a concrete base on grade with a mass equal to ten times the rotating mass of the equipment or a minimum of three times the gross mass of the machine, whichever is greater. Where this is not possible perform dynamic analysis and design of the foundation • Large equipment bases such as pumps/ couplers/ motors will be filled with epoxy grout • Where possible isolate vibrating equipment from the structure • Recommend use of vibration isolators or dampers where appropriate • In walkway framing, use steel support beam depths greater than or equal to 1/20th of the span to minimize perceptible transient vibrations.
NOTE: Special features shall be prepared for each structure by the lead structural engineer – see following pages.			

CLEARWELL – ETC – *REVISION 0*			
REV	**CATEGORIES**	**ITEMS**	**DESCRIPTION**
	SPECIAL FEATURES *(i.e. mech, arch, etc.)*	Clearwell Roof	• Clearwell roof covered in waterproof membrane, insulation, granular drainage layer, and soil, total ~600 mm thick • Roof slopes east and west for surface drainage • Granular drainage "tunnels" to exit from perimeter slopes to be spaced at +/-5 meters all around.
		Expansion joints	• The structure will require expansion joints, quantity and locations to suit the structure configuration and overall dimensions
		Permanent underslab drainage	• Permanent perimeter weeping tile to be installed to drain to collection pits and pumped to site drainage system • A layer of granular will be placed under the base on a layer of 10 mil poly and woven geotexile.
		Cell drainage	• The Clearwell floor will be sloped from the inlet walls to the outlet corner • baffle wall will have appropriate openings to accommodate drainage
		Weir	• The inlet chamber features a weir that requires precise contouring *Note: process to provide precise contouring information*
		Emergency exits	• Each cell requires two emergency outlets which will consist of structures on top of the Clearwell roof with exit hatches and aluminum exit ladders; the structures will also feature louvers for additional air relief venting.
		Inlet Building	• The inlet corner will feature a concrete building to accommodate the operation of the gates • Building interior vertical clearance will be set at a meter above the gate operator height requirements; this has been determined to be 5 m • Boat launches: one for each of two cells is required; openings through the floor will have insulated aluminum covers • Jib crane for boat launches – two required, one for each cell • Overhead doors openings - two required. *Note: Architect input required for door size, type, operation, and specifications* • Insulated floor: mechanical recommends an insulated floor; this requires a concrete sandwich floor construction with a 100 mm (or as per mechanical requirements) and a 100 mm concrete topping

REV	CATEGORIES	ITEMS	DESCRIPTION
	SPECIAL FEATURES *(i.e. mech, arch, etc.)* (Continued)		• Gate openings: the gates will require openings directly above each one through the floor and roof for removal by mobile crane; each opening will require an insulated aluminum cover or hatch
			• Ventilation: ventilation openings and shafts are required for each cell and for the inlet chamber; shafts are to be configured with trap walls to prevent debris falling through openings into the Clearwell • Clearwell Access: each cell and the inlet chamber requires a stair access complete with insulated aluminum covers (in sections to be manually removable); stairs and landings to be constructed of aluminum
		Outlet Structure	• Sump: the outlet structure features a sump approximately 2.7 m below the main base slab and accommodates a series of outlet gates; the sump lip must have guardrailing • Each side of the sump will require shallow floor depressions for clean out pumping
			• Insulated floor: due to rapid and frequent air changes mechanical recommends an insulated floor; this requires a concrete sandwich floor construction with a 100 mm (as per mechanical requirements) and a 100 mm concrete topping
			• Gate openings: the gates will require openings directly above each one through the floor and roof for removal by mobile crane; each opening will require an insulated aluminum cover or hatch
			• Ventilation: ventilation shafts and openings are required for each cell
	CONSTRUCTION & DESIGN FEATURES	Ground Water	• Varies greatly (Spring conditions, floodway operation, holdings cells)
		Soil	• Highly plastic clays over till layer on limestone bedrock
		Temporary drainage	• Temporary drainage will be required during construction to direct water to collection system at the SW corner; slopes and ditching will need to covered with impermeable lining
		Working base	• A granular working base will be required for the installation of the piles; an impermeable liner and a geotexile will be installed under the working base
		Monorail	• City says “no”
		Crane	• See note above for Outlet Building
		Adjacent structures	• Railway to north and west, water treatment plant to east

REV	CATEGORIES	ITEMS	DESCRIPTION
	SCHEDULING	Design schedule	• 75% by April 3, done (85%) by April 18/05
		Watertightness testing	• The exterior and dividing walls will be designed as cantilever walls so that watertightness testing or backfilling can be performed before construction of the roof slab.
	UNRESOLVED MAJOR ITEMS		• Final architectural features for walls and roofs
	SPECIFICATIONS		• Specification Sections required: o 02223 Excavation and Backfilling for Structures o 02451 Pile Foundation, General (Done) o 02468 Precast Concrete Piles (Done) o 03100 Concrete Formwork o 03200 Concrete Reinforcement o 03250 Concrete Accessories o 03300 Cast-In-Place Concrete o 03345 Concrete Floor Finishes o 03411 Precast Concrete Wall Panels (by Architect?) o 03600 Grout o 05500 Metal Fabrications (by Architect) o 05530 Aluminum Fabrications (by Architect) o 07??? Waterproofing Membrane (Clearwell roof) o 146?? Jib Crane
	DRAWINGS	List	• See Master List
		Standards	• See Appendix L of QMP
		Geodetic Elevation	• Geodetic @ DBPS • Nominal base slab elevation = 230.600
WATER TREATMENT PLANT – CH2M Hill - *PRELIMINARY*			
	OTHER SPECIAL FEATURES *(i.e. process, mech, arch, etc.)*	Gates	•
		Overhead doors	•
		Ozone production	•
		Low pH levels	•

REV	CATEGORIES	ITEMS	DESCRIPTION
	CONSTRUCTION & DESIGN FEATURES	Ground Water	•
		Soil	•
		Monorail	•
		Crane	•
		Adjacent Structures	•
	SCHEDULING		•
	UNRESOLVED MAJOR ITEMS		•
	SPECIFICATIONS		• Specification sections required: ○
	DRAWINGS	List	• See Master List
		Standards	• See Appendix L of QMP
		Geodetic Elevation	• Geodetic @ DBPS
BULK CHEMICAL STORAGE BUILDING – ETC - *PRELIMINARY*			
	SPECIAL FEATURES *(i.e. mech, arch, etc.)*		•
			•
			•
	CONSTRUCTION & DESIGN FEATURES	Ground Water	• Varies greatly (Spring conditions, floodway operation, holdings cells)
		Soil	• Highly plastic clays over till layer on limestone bedrock
		Temporary drainage	•
		Working base	•
		Monorail	•
		Crane	•
		Adjacent structures	• Railway to north, water treatment plant to south
	SCHEDULING	Design schedule	•
			•

REV	CATEGORIES	ITEMS	DESCRIPTION
	UNRESOLVED MAJOR ITEMS		•
			•
	SPECIFICATIONS		• Specification Sections required:
			•
	DRAWINGS	List	• See Master List
		Standards	• See Appendix L of QMP
		Geodetic Elevation	• Geodetic @ DBPS • Nominal base slab elevation =

BUILDING MECHANICAL (HVAC)

MECHANICAL DISCIPLINE LEAD: Alan M. Aftanas, P. Eng.

MECHANICAL DESIGN: Dave Cuddington, P.Eng.
Peter Tataryn, P.Eng.
Pertti Laitinen, P.Eng.

QA and REVIEW: John Munroe (Alternate: Chris Himsl) Formal Work Product Quality Reviewer

INTRODUCTION:

The mechanical scope of work includes the provision of mechanical building systems for the Winnipeg Water Treatment Plant. The scope of work includes the following major components:

Excluded from the mechanical scope of work are process-related mechanical systems, which will be designed by the Process Mechanical Discipline.

SCOPE AND DESCRIPTION OF STRUCTURE:

The following distinctions of work are defined for the Plumbing and Drainage Systems:

Building Mechanical Discipline to include:

- Plumbing associated with washrooms, sinks, lavatories, eyewash stations, etc. (i.e. domestic hot and cold water distribution, sanitary drainage pipes to nearest sump pit and vent piping).
- All sub-floor or sub-slab drainage piping, including floor drains (i.e. run to nearest sump pit).
- Roof drainage
- Utility water distribution for wash-down, including hose reels.

Process Mechanical Discipline to include:

- All above floor process drainage piping (e.g. drainage from a sample station to a floor drain, back-wash drains, etc.).
- Sump pumps and force-drain piping to main lift station.

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN BASIS	Mechanical Bldg. Systems	• HVAC, Plumbing, Roof Drainage and Fire Protection Systems • Our intention is to build an energy efficient (Power Smart) water efficient facility. • However, this will not be a LEED registered building.
	DESIGN CODES	General	• 1995 National Building Code • 1995 National Fire Code • 1998 Manitoba Plumbing Code Regulation 161/98 • 2000 Natural Gas Installation Code CAN/CGA-B149.1-00 with Manitoba Gas Notices (Sept. 2000) • ASME Boiler and Pressure Vessel Code • Manitoba Steam and Pressure Plants Act (S210) • Manitoba Power Plants Act (P95) • Model National Energy Code for Buildings
	DESIGN REFERENCES (Standards)	General	• ASHRAE Standard 62-2004 – Ventilation for Acceptable Indoor Air Quality • ACGIH-Industrial Ventilation –Manual of Recommended Practices – 19th Edition • National Fire Protection Association (NFPA) Standards • Sheet Metal and Air Conditioning Contractor's Association (SMACNA) – Duct Construction Standards • ANSI/ISA Standard S71.04 – Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants
	OUTDOOR DESIGN PARAMETERS (for Winnipeg)	Winter	• T_{db}= -35°C (January 1%) • $T_{db\ extreme}$ = - 40°C
		Summer	• T_{db}= 31°C T_{wb}= 22°C (July 2.5%)
		Rainfall	• D= 28 mm based on 15 minute rainfall
A	**INDOOR DESIGN PARAMETERS**	WTP – Process Areas	• $T_{db\ Min.}$ = 15° C • $T_{db\ Max}$ = 30° C • Certain areas may have additional temperature constraints based on process and chemical storage requirements (e.g. chemical storage areas)

REV	CATEGORIES	ITEMS	DESCRIPTION
	INDOOR DESIGN PARAMETERS (Continued)		• RH: control to prevent condensation on pipes, insulation, equipment and building surfaces. Humidity control must address evaporation loads from open process water (require annual temperature profile for process water for design). Note: it may be difficult to prevent condensation on process water pipes under all conditions, unless the piping is insulated. For example, there may be warm humid days in the springtime when the process water is still very cold and the piping surface is below the dewpoint temperature. • Ventilation: as required by Code and as required for a) heat removal b) humidity control c) control of air contaminants.. • Space Pressure: negative relative to outdoors (2 Pa to minimize potential for migration of moisture into building envelope). • Mechanical Filtration: Remove 85% of particles larger than 1 micron.
		WTP – Pump Rooms	• $T_{db\ Min.}$ = 15°C • $T_{db\ Max}$ = 37°C • RH: control to prevent condensation on pipes, insulation, equipment and building surfaces. • Ventilation: as required to dissipate heat when pumps are running. • Space Pressure: Neutral • Mechanical Filtration: Remove 85% of particles larger than 1 micron.
		WTP – Control Room	• $T_{db\ Min.}$ = 20°C • $T_{db\ Max}$ = 24°C • $RH_{Min.}$ = 30% • $RH_{Max.}$ = 60% • Ventilation: Per code. Provide minimum 20 cfm per person in accordance with ASHRAE standard 62 and maintain CO2 levels below 800 ppm. • Space pressure: Positive relative to process spaces. • Mechanical Filtration: Remove 95% of particulates larger than 1 micron.
		WTP – Administration Areas	• $T_{db\ Min.}$ = 20°C • $T_{db\ Max}$ = 24°C • $RH_{Min.}$ = 30% • $RH_{Max.}$ = 60% • Ventilation: Per Code. Provide minimum 20 cfm per person (in accordance with ASHRAE standard 62) and maintain CO2 levels below 800 ppm. • Space Pressure: Positive relative to process spaces. • Mechanical Filtration: Remove 95% of particulates larger than 1 micron.

REV	CATEGORIES	ITEMS	DESCRIPTION
	INDOOR DESIGN PARAMETERS (Continued)	WTP - Electrical Rooms	• $T_{db\ Min.}$ = 15° C • $T_{db\ Max}$ = 26° C • $RH_{Min.}$ = 30% • $RH_{Max.}$ = 60% • Ventilation: as required to dissipate heat (utilize free cooling). • Space Pressure: Neutral • Mechanical Filtration: Remove 85% of particles larger than 1 micron.
		WTP - Mechanical Rooms	• $T_{db\ Min.}$ = 20° C • $T_{db\ Max}$ = 30° C • $RH_{Min.}$ = 30% • $RH_{Max.}$ = 50% • Ventilation: Per code. Provide combustion air and vent for rooms with gas fired equipment in accordance with Gas Code. Provide ventilation as required to dissipate heat (utilize free cooling). • Space Pressure: Neutral • Mechanical Filtration: Remove 85% of particles larger than 1 micron.
		Bulk Chemical Storage Building	• Winter: $T_{db\ Min.}$ = 20° C • Summer: $T_{db\ Max}$ = 30° C (or as required to maintain stability of chemicals) • RH = control to prevent condensation on pipes, insulation, equipment and surfaces. • Ventilation: as required by Code. Provide capability for at least 6 ACPH of outside ventilation air. • Need to determine nature of chemicals to determine ventilation and containment (drain) requirements. • Space Pressure: Slight negative relative to outdoors (2 Pa). • Mechanical Filtration: Remove 85% of particles larger than 1 micron.
		Valve Chambers	• Winter: $T_{db\ Min.}$ = 10° C • Summer: $T_{db\ Max}$ = 38° C • Ventilation: These spaces will require "confined space entry" procedures. Provide ventilation to dissipate heat.
A	**HVAC STRATEGIES**	WTP – Process Areas	• Natural gas fired air handling equipment with capabilities to provide outdoor air for humidity control. • Separated combustion natural gas fired unit heaters for perimeter heating, as required (Evaluate if hydronic system makes sense). • Direct air flow from grilles away from open water

REV	CATEGORIES	ITEMS	DESCRIPTION
			surfaces to minimize evaporation.
	HVAC STRATEGIES (Continued)	WTP – Pump Rooms	• Natural gas fired air handling equipment with capabilities to provide outdoor air for ventilation and heat dissipation. • Separated combustion natural gas fired unit heaters for perimeter heating, as required.
		WTP – Control Room	• Water to air heat pump system using process water as energy source/sink. Provide secondary loop to eliminate potential for cross-contamination. • Fresh outdoor air to be provided via make-up air system. One make-up air system may be able to supply the Control Room and the Administration areas. • Provide natural gas boiler and fluid cooler as back-up. Possibly locate the boiler in central mechanical room. • Variable air volume air distribution to reduce fan energy consumption. • Provide CO2 control systems.
		WTP – Administration Areas	• Water to air heat pump system using process water as energy source/sink. Provide secondary loop to eliminate potential for cross-contamination. • Fresh outdoor air to be provided via make-up air system. One make-up air system may be able to supply the Control Room and the Administration areas. • Provide individual heat pump for each zone. • Provide natural gas boiler and fluid cooler as back-up. • Variable air volume air distribution to reduce fan energy consumption. • Provide CO2 control systems.
		WTP - Electrical Rooms	• Water to air heat pump system using process water as energy source/sink. Provide secondary loop to eliminate potential for cross-contamination. Use heat exchanger with process water circulating on one side of the HX and the heat pump loop on the other side. • Heat pump loop connected to administration/control room system to provide heat recovery from electrical rooms.
		WTP - Mechanical Rooms	• Provide combustion air and vent ducts per Gas Code. • Provide ventilation as required to dissipate heat (utilize free cooling). • Separated combustion natural gas fired unit heaters for perimeter heating, as required.

REV	CATEGORIES	ITEMS	DESCRIPTION
	HVAC STRATEGIES (Continued)	Bulk Chemical Storage Building	• Provide steam boiler for steam cleaning chemical rail cars. • Steam or natural gas fired air handling equipment with capabilities to provide outdoor air for humidity control. • Separated combustion natural gas fired unit heaters for perimeter heating, as required.
		Valve Chambers	• These spaces will require "confined space entry" procedures. Provide ventilation to dissipate heat only (if required). • Provide electric heater for temperature control.
A	**BUILDING ASSEMBLY**	HVAC Equipment	• Robust/Industrial Components • Natural Gas Fired Equipment – indirect fired • Mechanical Cooling • No R-22 refrigerant. • No canvas recovery jacketing (PVC or Aluminum only)
		HVAC Control System	• HVAC systems to be controlled by plant SCADA system with HMI located in Control Room. • HVAC systems to have their own graphics. • Instrumentation and controls to be commercial grade (e.g. Belimo), and compatible to SCADA I/O protocols (e.g. 4-20 mA). • Develop HVAC P&ID's for SCADA system tie-ins with I&C group.
		Additional HVAC Suggestions for Consideration	• The following concepts to be considered: o Central Plant to service WTP Process area air handling equipment o Condensing boilers o Heat Recovery from Ozonation Equipment o Heat Recovery from Electrical Rooms o LEED Registration.
		Fire Protection	• Sprinklers and standpipe system as required by Code review. • Sprinkler and standpipe systems to operate on raw water. Suitable pressures to be provided via Fire Pumps. • Provide Siamese connection for Fire Department Connection to yard hydrant system. • Provide Fire extinguishers as required.

REV	CATEGORIES	ITEMS	DESCRIPTION
	BUILDING ASSEMBLY (Continued)	Plumbing	• Low flow fixtures • Dual Flush Toilets • Wall hung flush valve urinals. If approved by COW use waterless urinals to conserve water.
		Potable Water	• Supply from Deacon Booster Pumping Station after final UV treatment.
		Utility Water	• Utility water system shall be separated by back-flow preventer from potable water systems.
		Sanitary Drainage System	• Sanitary wastes to be gravity fed to sump pits. • Sump pits will be pumped by force mains into the central lift station (design by Process Mechanical). • Sump pumps in the gallery areas for drainage, connected to the sanitary system. • May need sewage tanks with grinder type lift pumps for washrooms (gravity flow is better if we can make it work). • Heavy duty floor drains. Floor drain system to connect to sanitary system. • Funnel floor drains to be connected to sanitary system.
		Process Drains (and floor drains)	• Process drains to be designed by Process Mechanical Discipline. • Process drains for sampling stations to return to Residuals Management Area.
		Roof Drainage	• Internal roof drainage discharge to rainwater leaders discharging to grade.
	MAJOR UNRESOLVED ISSUES		• Electrical clarification in Chemical Building. Need MSDS sheets for chemicals stored. • Need to resolve locations of sump pits.
	APPROVED SUPPLIERS		• Pumps: ? • Valves: ? • Air Handling Units: ?
	ELECTRICAL LOADS SUPPLIED TO OTHERS		• To be supplied to Electrical
	WEIGHT LOADS SUPPLIED TO OTHERS		• To be supplied to Structural

REV	CATEGORIES	ITEMS	DESCRIPTION
	SCHEDULING		• Refer to CM Issue
	DRAWINGS	Refer to Master List	• Legend Page • HVAC Schematics • HVAC Plans & Sections • Hydronic Plans & Sections • Plumbing Plans & Sections • Roof Plan • Details

LEAD DISCIPLINE PROCESS MECHANICAL:

PROCESS MECHANICAL DESIGN:

QA and REVIEW:

INTRODUCTION:

SCOPE AND DESCRIPTION OF SYSTEMS:

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN BASIS		
	SYSTEM OF MEASUREMENT		
	DESIGN CODES		
	DESIGN REFERENCES		
	DESIGN PARAMETERS		
	SERVICE REQUIREMENTS		
	CONSTRUCTABILITY CONCERNS		
	CONSTRUCTION & DESIGN FEATURES		
	SCHEDULING		
	UNRESOLVED MAJOR ITEMS		
	SPECIFICATIONS		
	DRAWINGS		

DESIGN BASIS
ELECTRICAL

REVISION 0

DISCIPLINE LEAD ELECTRICAL: Petr Stryk, P. Eng. - ETC

ELECTRICAL DESIGN: Garrett Norsworthy/Shirley Xue Chen – ETC
James Thannickal /Larry Llewellyn – CH2M Hill

QA AND REVIEW: Brian Lockhart, P. Eng. – ETC
Lyle Taylor – ETC
XXX XXXX – CH2M Hill

INTRODUCTION:

The following electrical design brief for the Winnipeg Water Treatment Plant (WWTP) is based on the scope of work identified in the proposal document and currently referenced in the project plan. This document provides design basis for major electrical design aspects for the Winnipeg Water Treatment Plant.

SCOPE AND DESCRIPTION OF ELECTRICAL SERVICE AND SITE DISTRIBUTION:

The WWTP facilities are the Water Treatment Plant, Clearwell, Bulk Chemical Storage Building, Generator Building, Yard Piping Valve Chambers, Electrical Substation, and other ancillary structures (transformer pads, lagoon dewatering pump station, inlet and outlet distribution chambers).

The main 66 kV supply voltage from Manitoba Hydro will be transformed to 4160 V and then distributed throughout the (WWTP) site, including the existing Deacon Booster Pumping Station (DBPS). Two new service transformers and a main 5 kV electrical room will be located northwest of the proposed clearwell and the proposed WTP. From the 5 kV electrical room, the 4160 V power will be distributed to the Administration Building electrical room, to another electrical room in the Hypochlorite generation building, and to the existing DBPS.

Several 5kV/600V transformers will be installed through the site to provide 600 Vac for most of the process loads and for the building mechanical loads. Small equipment, instruments, lighting and the control system will be powered from 600/ 120/208 transformers and corresponding distribution system.

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN BASIS	Main Service Capacity	• 400 MLD, provisions for 600 MLD
		System Reliability and Redundancy	• All major components shall be 100% redundant and shall be sized to carry normal load and the load of failed counterpart.
		On site power generation capacity	• One process train (200MLD) to be on standby power; no separate standby power distribution; control system will lock-out certain loads during a power failure.
		Recovery after a failure	• Closed transition; bump-less re-transfer after a failure.
	DESIGN STANDARDS AND CODES (Latest Editions unless noted otherwise)	General	• Canadian Electrical Code (CEC) and all local amendments. • Canadian Standards Association (CSA) • CSA C22.1-02 Safety Standard for Electrical Installations • Electrical and Electronic Manufacturers of Canada (EEMAC) • Institute of Electrical and Electronics Engineers (IEEE) • Insulated Cable Engineer's Association (ICEA) • American National Standards Institute (ANSI) • Illuminating Engineering Society (IES) • National Electrical Manufacturers (NEMA) • American Society for Testing and Materials (ASTM) • National Fire Code of Canada (TBConfirmed) • Underwriters Laboratories of Canada (ULC)
		Hazardous locations (if applicable, i.e. chemical building) Fire Alarm System (if required)	• NFPA XXX? • CAN/ULC Standards
		Harmonic Control	• IEEE 519
			•
			•
			•
			•

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN PARAMETERS	Electrical System Capacity, future considerations	• 400 MLD, provisions for future 600MLD
		Equipment sizing and feeder capacity	• Dual feed to all major distribution centers • All components sized to carry normal load and load of failed counterpart • Split bus with tie breaker normally open •
		System flexibility, ease of maintenance	• Switching scheme to isolate faults. • Switching scheme to isolate equipment for regular maintenance • TBC
		Service Ground	• Resistance Grounding with monitoring instruments
		Voltages	• Utility 66kV • Site Distribution 4160 V • Motors above 350HP 4160V • Motors ¾ - 350 HP, building and process loads 600 V • Motors up to ½ HP 120 V • Transformers 5 kV/600 V/347 3 phase, 4 wire; transformer secondary neutral points shall be solidly grounded wye • 120/208V 3 phase, 4 wire; transformer secondary neutral points shall be solidly grounded wye • Fluorescent, metal halide, high-pressure sodium, and incandescent lighting shall be 120-volt, for **specific** situation 347V. • Heaters up to 1,500 W, convenience outlets, motor controls, and motors less than 3/4 horsepower (hp) 120-volt. • Heaters above 1,500 W 600V • No single phase L-N loads to be supplied directly from secondary of 600V transformers; - **to be discussed.**
			•
			•
	DRAWINGS	Legend Sheet	• symbol/legend sheet to contain symbols and abbreviations used in the drawing set • TBC
		Site Plans	• Will show the location of all facilities and major equipment, duct banks routes and manholes

REV	CATEGORIES	ITEMS	DESCRIPTION
	DRAWINGS (Continued)	Single Line Diagrams	• Will show distribution system from its point of service to 600V utilization devices and 120/208V panelboards. Circuiting of 600V panelboards for major loads shall be shown on the single line diagram; circuiting of 600V, 120/208V panelboards will be shown on drawings in the typical 3-line format. • Included will be bus capacity, short circuit fault ratings (kA), overcurrent device types and ratings, breaker frame and trip ratings, protective relay types and ratings, metering and load ratings (kilowatt).
		Elevations	• Will shown medium voltage switchgear, low voltage switchgear, and 600V motor control centers. It will show locations of starters or breakers within an MCC or panel, door mounted relay devices, metering, and conductor entrances. Show MCC units with extra height where required for relays

		Motor control schematic diagram (MCSD)	• Will show control circuit devices. Motor Schedule with a table listing control devices can be used
			• Momentary or maintained control to be considered with process engineer – main issue is restart after a power failure.
			• The following control devices shall be shown on the MCSDs
			  ○ HOA switch (where required)
			  ○ START/STOP Push Buttons (where required)
			  ○ ETM
			  ○ Ground fault relays
			  ○ Metering
			  ○ Motor thermal devices
			  ○ ON/OFF and ALARM status lights
			  ○ Motor CT's
			  ○ Ground fault CT's
			  ○ ESD
			  ○ Line disconnect
			• Control devices 1 through 9 as listed above to be located in motor controller (i.e motor starter, soft starter, VFD)
			• Control devices 10 (ESD) and 11 (Line disconnect) as listed above shall be located in the field by the process equipment.
			• HVAC equipment control will be provided by Div. 15

REV	CATEGORIES	ITEMS	DESCRIPTION
	DRAWINGS (Continued)	Schedules to be provided	• Luminaire Schedule for 1. Process areas 2. Corridors 3. Offices areas 4. Any other? • Panel Schedules; in a 3-line format. A separate panel will be provided for each facility for the power supply to process related instruments and equipment. In smaller facilities, this panel may be subfed from the lighting panel but in larger facilities it shall be fed from a transformer that is separated from the building facilities power supply. Where sensitive instruments need to be powered from facilities that also contain variable frequency drive systems, a shielded transformer shall be provided to power them. In other facilities the panel may be subfed from the lighting panel.
		Details	• Details will be numbered. A preliminary set of design details will be selected and a copy of each will be provided to each design team member. All detail that are being used will be in the book. Details will be the ET-CH2M standard details. To be discussed.
		Process and Facility Plans	• Will show the location of and connection to all equipment, which require raceway or conductors. A separate connection point shall be shown for each device located within a process area even if they are all supplied as part of the same package unless the specifications clearly require that all of the devices are to be wired to a single panel or TJB by the supplier of the equipment. Spare raceway for future equipment shall also be shown and clearly labelled, where appropriate. On the facility plan show receptacles, lights, water heaters, HVAC equipment and other non-process loads.
		Connection to I&C Provided Equipment	• All instruments individually fused (breakers or Weidmuller knife-style fused terminals) • All control loops individually fused (Weidmuller knife-style fused terminals) • All I/O points (Weidmuller knife-style fused terminals) • 24 VDC power supplies to be fully redundant; if one unit fails it shall not effect the operation of the redundant unit; power supply failure shall be alarmed and operator shall be notified. • Final connection to all I&C supplied equipment will be shown on the drawings as being made by the electrical subcontractor; to be coordinated with I&C Division.

REV	CATEGORIES	ITEMS	DESCRIPTION
	ELECTRICAL EQUIPMENT CONSIDERATION	Equipment identification	• The following equipment will be identified 1. Motor control centers 2. Panelboards 3. Distribution panelboards 4. Switchgear 5. Terminal junction boxes **6.** Cables to be identified with cable #; and with "from" (power source; panel & circuit #) "to" (power destination; panel & circuit #) information. **Information to be provided on Cable Schedule).** • Use mechanically attached Lamacoids • Use encircled wire markers for cable identification. • Other equipment may be identified if identification is required for other purposes
		As built Single Line Diagram	• As built Single Line Diagram shall be provided as full size drawing in each electrical room.
		Distribution System Protection	• The following types of protective devices shall be used 1. 66 kV main switchgear assembly- Fused load break switches 2. 4,160 volt motor control--drawout type vacuum contactors in NEMA 1 gasketed enclosure, one-high construction 3. 600V main, tie, and feeder circuit breakers in new switchgear assemblies, 100% rated power circuit breakers with solid state trip units 4. 600V motor control center main circuit breakers--moulded case thermal magnetic breakers 5. 600V motor control center tie breakers – moulded case circuit breakers 6. 600V motor control center branch circuit and breakers (other than combination motor starters)--moulded case thermal magnetic • Equipment shall have adequate momentary and interrupting capacity to withstand fault currents that may occur at the point in the system where the equipment shall be applied • Main breakers and tie breakers (moulded case circuit breakers) on MCC's shall be 100% rated breakers. These shall still be represented with a frame and trip rating. If the trip rating does not match the size of a frame rating, then the breaker shall still be a 100% rated breaker, however, with a smaller trip unit • Each circuit breaker that is located immediately downstream from the secondary main on a 600V secondary transformer shall be equipped with ground fault protection unless that circuit is rated 1000A or less

REV	CATEGORIES	ITEMS	DESCRIPTION
	ELECTRICAL EQUIPMENT CONSIDERATION (Continued)		• Each circuit breaker protecting a motor of 100 horsepower or more shall be equipped with ground fault protection • Ground fault protection on motors shall be instantaneous type and ground fault protection on main breakers and feeder breakers shall be equipped with time delay setting and restraint systems • Coordination Study shall be provided. • Any other?
		Motor Protection and Control	• Magnetic only circuit breakers shall be provided as a branch circuit protection in motor starters for all motors 50 hp and smaller. Branch circuit protection for larger motors shall be provided by thermal magnetic breakers with adjustable magnetic trips • Each motor shall be provided with thermal overload protection in all ungrounded phases. Controller-mounted relays shall have external manual reset. For motors with motor starters, the overload protection will be in the motor starter. For fractional horsepower equipment not normally requiring motor starters, manual motor starters with overload protection will be added. Some small equipment such as ceiling fans will have overload protection integral with the motors • Internal temperature detectors embedded in motor windings shall be specified for motors of 50 hp and larger including motors that are powered by a variable frequency drive. Temperature detectors in motors shall be equipped with thermistors, motors larger than 300HP shall be equipped with RTDs. Multi-function protective relays, GE Multilin SR469, for overload, phase protection, and ground fault protection shall also be provided on 4160 volt motors • All motor control circuits shall operate at 120 volts and shall be supplied by individual control power transformers fused both phases in the primary and one phase on the secondary side. Secondary neutral tied to ground • Electrical motor starter control shall normally consist of indicating lights, pushbuttons, or switches. Devices connected with process controls, such as timers and auxiliary relays, shall be provided in instrumentation and control panels or operated by a programmable logic controller as part of its internal control logic. This will be coordinated with I&C for each item • Indicating lights shall be push to test style • Starter control will be typically "HOA" "Start/Stop". Momentary or Maintained type of control needs to be determined on individual basis, depending on the application. • All Motor Starters shall be NEMA rated

REV	CATEGORIES	ITEMS	DESCRIPTION
	ELECTRICAL EQUIPMENT CONSIDERATION (Continued)	Motor Control Center	• MCCs will use design around Square-D or approved equal, but use the same manufacturer for all designs. • Vacuum breakers shall be used in 5kV distribution, (i.e.5 kV motor starters) – to be finalized • Spares and spaces should be allowed – to be determined - to the identifiable spares required for known future equipment. Allow space for at least one future section at each MCC. • Include digital Power Monitoring Instrument capable of measuring, calculating and displaying V, I, Fr, PF, kVA, kVAR, kW, tot kWh, kW demand, I demand, kVA demand. • Other??
		Equipment Disconnects	• Provide disconnects where required at process equipment. • Disconnects for motor-operated valves and gates will be specified as integral disconnects • Integral disconnects shall be provided with process equipment as a standard option where available. • Provide disconnect switches for all HVAC equipment that has any integral controls (i.e. unit heaters, compressors, duct heaters, air handlers, etc.). • Provide a local disconnect for all hoisting equipment overhead cranes, and motor operated rollup doors • For VFD's fed from MCC's, the lockable disconnect at the VFD is adequate • Motor rated toggle switches shall be used for small motors; Regular disconnect switches shall be shown for larger pieces of equipment • Disconnects for HVAC equipment that requires HACR rated devices shall be fused safety switches
		Panel boards	• Generally, provide a separate circuit breaker for each instrument or control element • Where multiple instruments or control elements are connected to a single-branch circuit, a fused disconnect switch shall be provided for each instrument / control element. • Identify all branch circuits or feeders on the drawings • Lighting panel boards shall be surface-mounted, 120/208V, 3 Ph, 4-W type with the main circuit breaker sized to match the lighting transformer capacity. • Separate panel boards shall be provided to supply power to instruments and control panels where the equipment to be supplied requires a conditioned power supply. **UPS shall be considered as power conditioner**. • Each panel board shall be with a minimum of 20 percent spare breakers, spaces, bus work, and terminations.

REV	CATEGORIES	ITEMS	DESCRIPTION
	ELECTRICAL EQUIPMENT CONSIDERATION (Continued)		• Panel board schedules shall show the circuit description, protective device trip rating, number of poles, rating of main lugs or main circuit breaker, neutral bus size, ground bus size, and interrupting rating of breakers. Computer-generated panel board schedules shall be included in the drawings
		Convenience Receptacles	• Shall be spaced not more than 15m apart inside all process building and 20m apart in outside process areas and shall be located on the surface of walls or columns • Shall be located as needed in office/corridor areas – generally 15 m O.C. in corridors and as required in offices. • Shall have separate neutral conductor for all non-linear loads (computers, lighting using ballasts.) • Washroom and outdoors receptacles shall be ground fault protected • Receptacles in washdown area – shall be 1.5 m AFF mounted in angled device boxes with WP covers and GFI breakers.
		Welding Receptacles	• Welding Receptacles shall be in all process areas • The Receptacles shall be **XXX** m apart – to be discussed • The Receptacles shall be Crouse Hinds – model number to be finalized •
		Variable Frequency Drives	• Variable frequency drives will be standard 6 pulse units to 75hp, 75hp and greater to be minimum 12 pulse. • VFDs shall be supplied with minimum 3 % line reactor, Mirus filter or phase shifting transformer for 12 or higher pulse system. • VFDs shall be ABB ACS drives – client preference. • VFDs shall be supplied with process equipment where practical. Equipment supplier shall be responsible for matching the VFD with motor, including dV/dT filters and inverter duty motors. • VFDs smaller than 40HP will be located within the MCC and 40HP and above will be located outside the MCC in its own cabinet
		Soft Starters	• Generally for motor loads 200 HP and above, soft starters to be used – subject to further discussion. • Soft Starters shall be supplied with bypass contactor and with a contactor for a power factor correction capacitor. • Design around Benshaw – client preference • Use of soft starters may not be suited for all applications; individual evaluation and justification will be required. – Comments?

REV	CATEGORIES	ITEMS	DESCRIPTION
	ELECTRICAL EQUIPMENT CONSIDERATION (Continued)	Harmonic Control and Power Factor Correction	• Filters, line reactors shall be specified and supplied with VFDs • Harmonic Analysis shall be done after the electrical system has been commissioned • Based on the Harmonic Analysis a Detuned Power Factor Correction System with Harmonic Filters may be provided.
	STANDBY POWER		• Standby power capacity for one process train (app. 5MW) • Generator voltage 4160 V; generators will be connected to the main 5 kV bus • Generators will be synchronized with each other and with the utility • No separate standby power distribution on site. The entire plant could be powered form the generators. • Control system will lockout pre-selected el. loads when utility power fails and generators provide power to the plant.
			•
	UPS POWER		• One UPS unit per Electrical/Control room or process area; exact location to be discussed; • No single UPS unit for the entire plant. • No single UPS unit per control panel. • Each UPS shall be true-online with static and maintenance bypass. • Distribution panel shall be provided with each UPS
			•
	POWER SMART	Motors	• High efficiency motors •
		Lighting	• High efficiency electronic ballasts • Occupancy sensors and control – motion detectors to be finalized
		Feeder Size	• Minimize losses, increase size of long feeders
		Other?	•
			•

REV	CATEGORIES	ITEMS	DESCRIPTION
	WIRING METHODS	Raceways: general guidelines for sizing, selection, and installation	• Cable tray the preferred raceway method • Cable tray shall be rigid Aluminum ladder type in process areas; follow installation guidelines, no contact with concrete. • If conduit is used: 1. In process areas, it shall be rigid aluminum; follow installation guidelines, no contact with concrete. 2. In non-process (i.e. office) areas: Concealed conduit shall be EMT. Exposed conduit shall be rigid steel up to 1.5 m above finished floor in dry areas, otherwise EMT. • Exposed raceways shall be installed in process areas. • Concealed raceways in walls and ceilings shall be installed in control rooms, offices, and all areas with finished interiors • Exterior, underground, concrete-encased, direct-buried conduit shall be schedule 40 PVC • The minimum diameter of exposed conduit in all areas shall be 19mm. Raceways in duct banks shall not be smaller than 52mm • Embedded and buried nonmetallic conduits shall be converted to metallic conduit before existing from masonry or earth and galvanized steel shall be used at all bends greater than 30 degrees; **All embedded and buried nonmetallic conduits shall be accurately documented and shown on as-built drawings; All stub-ups shall be identified with "From" "To" information**. • Duct banks shall include a minimum of two spares. In all cases, provide duct bank sections • The number of conduit bends shall be limited to an equivalent of 270 degrees on long runs • Conduit runs, junction boxes, and exposed wall penetrations should not be used on building exteriors
		Wire and Cable	• Copper conductors shall be used for all lighting, power and control wiring. • Minimum No. 12 AWG for power, minimum No. 14 AWG for control. • The current carrying capacity of conductors shall be based on 90°C insulation ratings for all circuits • Insulation shall be chemically cross-linked, thermosetting polyethylene, and, unless otherwise specified, rated RW90, or RWU 90, 1000 V.

REV	CATEGORIES	ITEMS	DESCRIPTION
	WIRING METHODS (Continued)		• Cable shall be Teck 90; if Teck cable is not installed in cable tray, then it shall be properly supported – **to be finalized.** • Power conductors will typically be 3C cable. Unless absolutely necessary, the largest 3C cable will be 500MCM and the largest 1c cable will be 750MCM. • Bonding and Grounding conductors shall be insulated, minimum #12 AWG; No conduit shall be used for bonding / grounding. • Any other?
		Neutral Sizing and Wiring	• All 120 VAC circuits shall use dedicated neutral • Any neutral size reduction to **be discussed** – harmonic control
	LIGHTING	Lighting levels	• Lighting levels in various areas shall be calculated as recommended in the Illumination Engineering Society (IES) handbook. • The following minimum foot-candle level shall be provided: 1. Office 70 2. Process, inside 30 3. Process, outside 5 4. Storage, inside 10 5. Walkway, corridor 10 6. Walkway, outside 2 7. General site 1 • The following general types of light source shall be used to provide the proposed foot-candle levels: 1. Office Fluorescent 2. Process, inside to 3.5 m Fluorescent 3. Process, above 3.5 m Metal Halide 4. Storage, inside Fluorescent 5. Walkway, corridor Fluorescent 6. Walkway, outside Metal Halide 7. General site Metal Halide • Lighting controls for areas that require more that 3 switching location shall be low voltage remote control wiring system type • All luminaries in indoor non-process areas shall be accessible by step ladder – **to be finalized for process areas.**
		Battery packs	• In all electrical rooms • As required by code – to be finalized
		Exit lights	• As required by codes - to be finalized • Exit lighting to be self powered

REV	CATEGORIES	ITEMS	DESCRIPTION
	SURGE PROTECTION	General	• Shall utilize non-linear voltage dependent metal oxide varistors or selenium cells • Shall not utilize gas tubes, spark gaps, or silicon avalanche diodes
		Protection levels	• Main panel • MCC • Branch panel • Individual Equipment/ UPS shall be used for instruments. • To be finalized
	FIRE ALARM		• Shall be installed in accordance with CAN/ULC S524 Standard for Installation of Fire Alarm Systems
			•
	SECURITY SYSTEM		• To be finalized
			•
	TELEPHONE SYSTEM		• To be finalized • CAT 5E based • BL to discuss
			•
	LAN FIBER OPTIC	Division 17 to address	•
			•
	TBD		•
			•
NOTE:			

INSTRUMENTATION AND CONTROLS

DISCIPLINE LEAD I&C: Stephen Tormey, P. Eng.

I&C DESIGN: **Blair Moore, P. Eng., Brian Larson, Neal Toulson**

QA AND REVIEW: **Mike Sell?**

INTRODUCTION:

The design of the instrumentation and controls systems encompasses the selection and installation guidelines for all instrumentation required to monitor the water treatment process, the design of the plant control system and the design of the operator interface to the plant control system. Instrumentation and Controls design will proceed according to the parameters laid out in the Automation Guidance Document (AGD) while incorporating basic I&C philosophies to produce a design that provides functionality, reliability, modularity (ability to expand) and ease of maintenance.

SCOPE AND DESCRIPTION OF THE CONTROL SYSTEM:

The water treatment plant control system will actually consist of two networks: a control network and an operator interface network. Each network will be a fully redundant Ethernet based network. Data will flow from one network to the other via redundant server computers that collect data from the plant control network and serve it to the Human Machine Interface (HMI) computers on the operator interface network. Modicon based PLCs will be utilized as the primary process controllers and will reside on the plant control network. Local HMI computers will be provided in each process area and will reside on the operator interface network. By segregating the two networks, we believe that inter device communication and resulting plant control can be achieved in a more efficient manner.

A third device level network is currently being considered. This network would interface between intelligent end devices and PLCs. The addition of such a device network would make more end device information available to the control system than traditional hard-wiring. At this point in time, Modbus/TCP and Profibus-DP protocols are being considered because these protocols are more widely accepted at the device level than the other protocols that Modicon offers interface modules for. The device level network will probably be limited to electric actuators, variable speed drives and power metering.

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN BASIS	Operator Interface Network	• Ethernet. Modbus/TCP protocol. • OPC if and when required. • Windows Operating System. • Hot Standby • Redundant Server machines
		Control Network	• Ethernet. Modbus/TCP protocol. • Modicon PLC based. • Hot/Standby Processors • Remote I/O • Redundant communication cabling.
		Level of Automation	• Remote plant control/monitoring from a centralized control room will be the norm. As such, all parameters necessary for complete plant control/monitoring will be available on the operator interface network. • Local motor control will also be available. • Smart devices will be used where appropriate
		Interface to other Networks	• Firewall between the Regional Water Distribution SCADA and the Operator Interface Network. • Institute a Demilitarized Zone (DMZ). Both networks can read/write to DMZ but do not have direct access to each other.
		Automation Guidance Document (AGD)	• Remote Control/Monitoring of all parameters required for plant operation. • Flow pacing and flow metering of chemical feed systems. • Automatic filter backwash and backwash timing logic. • Extensive use of online analyzers. Analyzers to be specified with fault detection. Prudent use of redundant analyzers. • UPS for main shutdown valves, critical sensors and transmitters, control system. • Automatic shutdown systems • Self-healing network (redundant paths) with fibre optics between network switches. • Virus Protection Software • 21 Steps to Improve Cyber Security of SCADA Networks. • Room for a Test Lab along side the engineering workstation(s) will be provided in the programming/configuration office. • Redundant Data Centers – preferably in two separate buildings.

REV	CATEGORIES	ITEMS	DESCRIPTION
	SYSTEM OF MEASUREMENT	Metric	• Level: mm, m • Flow: l/s, Ml/day • Pressure: kPa • Valve, Gate Position: % Open • Speed, Frequency: % Max. • Temperature: Deg C. • Power: kW
	DESIGN CODES		• **C22.1-02**: Canadian Electrical Code, Part I • Local Amendments to the Canadian Electrical Code. • Canadian Standards Association (CSA)
	DESIGN REFERENCES		• **IEEE 100-88:** Dictionary of Electrical and Electronic Terms • **ISA RP12.6-87:** Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations • **ISA-S5.1-1984(R1992)**: Instrumentation Symbols and Identification. • **ISA S5.4-76:** Instrument Loop Diagrams • **ISA S51.1-79:** Process Instrumentation Terminology • **NEMA 250-85:** Enclosures for Industrial Controls and System • **NEMA ICS 1-88:** General Standards for Industrial Control and Systems • **NEMA ICS 2-88:** Industrial Control Devices, Controllers, and Assemblies • **NFPA 70-1999:** National Electrical Code (NEC) • **SAMA PMC 17-10-63:** Bushings and Wells for Temperature Sensing Elements • **UL 1012-89:** Power Supplies • **Marshall, Perry S. & Rinaldi, John S.:** Industrial Ethernet 2nd Edition, ISA, 2005
	DESIGN PARAMETERS	Operator Interface Network	• Enterprise class Historian • Redundant Application Servers • Redundant Terminal servers hosting centralized operator interface. • Engineering workstation. • Local HMI's resident in each process area. • HMI Monitors: 20" LCD • Network Switches: Industrial Grade • Password determines Levels of Access • Fibre optic communication between buildings
		Firewalls	• Intrusion Detection Systems

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN PARAMETERS (Continued)	Control Network	• Will attempt to segregate duty/standby systems so that the duty I/O resides on a separate module from the standby I/O. • Fibre optic communication between buildings
		I/O Types	• Motor Discrete I/O: Isolated 120 VAC inputs and outputs. • Other Discrete I/O: Non-isolated 120 VAC Inputs and outputs. • Hard wired Analog I/O: 4-20 mA
		Typical I/O	• 4160 V Motor Starters: Start Command, Stop Command, Running Status, Stopped Status, Computer (Auto) status, Motor Tripped Status, 4-20 mA Current feedback. • FVNR Motor Starters, 600 V and below: Start command, Run status, Computer (Auto) status, Ready status • Variable Speed Drives: 4-20 mA Speed control, 4-20 mA Speed feedback, 4-20 mA Current feedback, Start command, Run status, Computer (Auto) status, Ready status • Electric Actuators, non-modulating: Open command, Close command, Computer (Auto) status, Open status, Closed status • Electric Actuators, modulating: Computer (Auto) status, Open status, Closed status , 4-20 mA Position control, 4-20 mA Position feedback, • Transformers: Winding temperature high alarm and trip status, Oil temperature high alarm, Oil level low alarm, Vacuum pressure high alarm, Grounding resistor circuit open alarm. • Generator Sets: Engine Running Status, Radiator fan Running Status, Computer (Auto) status, Generator Alarm status, Generator Fault status, Radiator fan Fault Status, Transfer Switch in Generator Position Status, Transfer Switch in manual bypass position Status. Building/Enclosure temperature and ventilation I/O TBA. • Transmitters: 4-20 mA process feedback, Fault status • Unmanned buildings: Motion detected alarm, Door switch operated alarm. • Fire Alarm Panel: Fault status, fire detected status. • Power Meters: Volts, Amps, kW, kVA, kVAR, Hz, Harmonic Distortion - All via Modbus/TCP interface. Fault Status hardwired. • UPS: System normal status, Bypass not available status, On Battery status, On Bypass status, Shutdown Imminent Alarm. • TVSS: Surge Protection Device Fault status.

REV	CATEGORIES	ITEMS	DESCRIPTION
	DESIGN PARAMETERS (Continued)	I/O monitored via proposed device level network	• 4160 V Motor Starter motor management relay (Multilin): Type of trip and bearing temperature alarms. • Variable Speed Drives: Control and Statuses as outlined above. • Electric Actuators, modulating: Control and Statuses as outlined above. • Generator Sets: Status' outlined above. Individual alarm and fault statuses such as low oil level, low fuel level, etc. instead of Common Fault & Alarm statuses. • Power Meters: Status' outlined above. • UPS: Status' outlined above.
		PID's	• Follow standards generated at pre-design stage. • ISA standards for instrument device identification will be followed.
	SERVICE REQUIREMENTS		• Modicon PLC's will be hard-specified.
	CONSTRUCTABILITY CONCERNS		• Interface between Regional Water Supply SCADA and WTP interface network must address security concerns.
	CONSTRUCTION & DESIGN FEATURES	Control System	• The control system will be split into 2 networks: An operator interface network and a control network. The interface between the two networks will consist of a pair of server computers that will provide real time fail-over in the case of a fault on the primary server. • Communication redundancy will be provided for both networks in the form of redundant cables, network switches and interface modules. • Local HMI and controllers will be provided at each primary process area.
	SCHEDULING	Control System Network Design	• Commences Immediately
		Generation of Templates for Lists, ILD's etc.	• Commences Immediately
		Instrumentation Design, wiring and Interface to control system.	• Commences at 70-80 % completion of process design.

REV	CATEGORIES	ITEMS	DESCRIPTION
	UNRESOLVED MAJOR ITEMS		• Regional Water Supply SCADA control room relocation. • Would like direction from the City regarding requirement for redundant data centers and need for these centers to be located in separate buildings. Due to the required speed of communication between main and backup servers, do not believe the infrastructure is in place to locate backup server at McPhillips. • Need to coordinate with electrical regarding UPS. Central UPS is preferable. UPS in each process area? • Interface with City of Winnipeg corporate network. Firewall(s) must be installed. Currently out of scope however must interface with City IT staff to ensure the interface to the corporate LAN is not restricted by WTP control system design.
	SPECIFICATIONS		• A preferred Instrument supplier list will be developed. • A Standard Specification template has been created.
	DRAWINGS	Refer to the master list	• Legend Sheet • Network Architecture • Interface to DBPS – Firewall & Connection Details • Typical Instrument Loop Diagrams • Instrumentation Location Drawings • Instrument installation details • I/O Lists • Instrument Index • Instrument Cable lists • Marshalling/Control Panel Interconnection Diagrams

PROCESS MECHANICAL

LEAD DISCIPLINE PROCESS MECHANICAL: Paul Wobma, P.Eng.

PROCESS MECHANICAL DESIGN: Ray Bilevicius, P.Eng., Albert Li, P.Eng., David Pernitsky, P.Eng., Simon Breese, P.Eng., Toby Brodkorb, P.Eng., Jason Sinclair, P.Eng., Sunny Mangat, P.Eng., Barry Williamson, P.Eng. Kim Schurtz, C.E.T.

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INTRODUCTION:

This memorandum will guide engineers and designers during the detailed design phase of the Winnipeg Water Treatment Plant. The process mechanical design basis will streamline engineering effort by presenting information common to most unit processes, and provide design uniformity regardless of which firm or office completes the design of a particular unit process. The purpose of this memorandum is to present the general design philosophies and considerations for the mechanical systems located throughout the plant.

SCOPE AND DESCRIPTION OF SYSTEMS:

The process mechanical scope of work includes provision for hydraulic and process sizing of the water retaining structures, conduits and piping systems. Detailing and specifying of process equipment and related piping and valving systems will be core functions of the process mechanical design team. The process designers will also have input into the instrumentation and controls design to preserve the design intent and functionality. Special attention will be given to equipment layout and support/restraint of major piping systems to support the structural design.

REV	CATEGORIES	ITEMS	DESCRIPTION
1	**DESIGN BASIS**		Refer to Section 2 of the PDR for a Summary of the Unit Process Design Basis
1	**CALCULATIONS & SYSTEM OF MEASUREMENT**		**General** • Describe all documentation in Metric (SI) units • Equipment and piping calculations are to be prepared and reviewed in accordance with this design basis. • This document describes calculations and/or support data required as part of the detailed design phase. Other calculations not listed may also be needed for specific facilities or systems. • All calculations are to be checked by the Discipline Lead (or designee) as defined in the QMP QA/QC procedures. • Computer calculations are acceptable provided the programs used are accepted by the firm leading that portion of the design, the calculation and method are easily traceable, and the final calculations are checked by the Discipline Lead. • Calculations are also required to estimate emissions from certain combustion equipment (where applicable). **Typical Calculations Performed by Mechanical Designers** • Pressure piping thrust calculations, as described under Plant Piping below. • Piping thermal expansion calculations for piping systems operating above 65°C. • Control valve sizing calculations, as described under Valves, Gates and Actuators. • Compressed air system calculations supporting compressor and receiver selection for process equipment air and control valve actuation • Heat exchanger sizing calculations. • Calculations supporting selections of all process mechanical equipment based on detention time, overflow rate, solids loading, gas transfer, mixing energy etc. Selection of equipment shall be accompanied by completed copies of equipment data sheet. • Calculations for heating and ventilation air systems and odour control (if applicable) shall be conducted using the methods presented in the Winnipeg WTP Building Mechanical (HVAC) Design Basis**.**
1	**DESIGN CODES AND STANDARDS (Latest Editions)**	**General**	• CSA - Canadian Standards Association • ASTM – American Society for Testing and Materials • ANSI – American National Standards Institute • ASME – American Society of Mechanical Engineers • ABMA – American Bearing Manufacturers Association (formerly AFBMA) • AWWA – American Water Works Association • ISA – Instrument Society of America • SSPC – Society of Protective Coatings

	DESIGN CODES AND STANDARDS (Latest Editions) (Continued	**General (Continued)**	• NSF/ANSI Standard 61 – Drinking Water System Components • Design Standards for Waterworks (10-State Standards) • Manitoba Building Code • Manitoba Fire Code • National Building Code of Canada • Manitoba Workplace Safety and Health Act and regulations, guidelines and code • NFPA - National Fire Protection Association codes for area classification will be adopted. • The codes and standards listed in the sections below are for guidance to the Engineers and Designers only, and are not intended to be a complete list of the applicable manufacturing and construction standards for the WTP. For more complete listings of the applicable codes and standards refer to the Project Standard Specifications
1		**Plant Piping Systems**	• Provincial and local codes governing water piping systems, flammable and combustible liquids, flammable gases, and hazardous chemicals are frequently in place. Acquaint yourself with these requirements before starting design work. • Fabricated (welded) steel piping should be designed in accordance with AWWA Manual M11, *Steel Pipe – A Guide for Design and Installation.* • ANSI/AWWA C200-97: *Steel Water Pipe-6 In. (150 mm) and Larger* • ANSI/AWWA C208-01: *Dimensions for Fabricated Steel Water Pipe Fittings* • ANSI/AWWA C207-01: *Steel Pipe Flanges for Waterworks Service - Sizes 100 mm through 3,600 mm* • ANSI/AWWA C213-01: *Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines* • ANSI/AWWA C220-98: *Stainless-Steel Pipe, 100 mm and Larger* • AWWA C220a-99: *Amendment 1 - Stainless-Steel Pipe, 100mm and Larger* • ANSI/ASME B31.3 – Process Piping Ductile iron piping systems wall thickness should be designed in accordance with AWWA C150, *Thickness Design of Ductile Iron-Pipe.* AWWA Manual M41, *Manual of Water Supply Practices – Ductile Iron Pipe and Fittings*, provides design guidance on

	DESIGN CODES AND STANDARDS (Latest Editions) (Continued)	**Plant Piping Systems (Continued)**	buried ductile iron piping design for pressure class and thrust restraint. • Pipe manufacturers and fabricators also provide much design information and they should be consulted early in the project. • ANSI Z53.1 - *Safety Color Code for Marking Physical Hazards* • NFPA 30, Vol. 3 – *Flammable and Combustible Liquids Code* • CSA B149.1 – Natural Gas and Propane Installation Code. • Piping is furnished in varying chemical compositions and manufactured by a variety of processes. These factors cause pipe within a generic group to have different physical characteristics such as tensile and yield strengths, creep resistance, resistance to heat, cold, and fatigue, etc. • The codes should be checked carefully before choosing piping types and grades for design or specifying them. For example, stainless steel piping manufactured under ASTM A778 and fittings manufactured under ASTM A774 are not recognized in the codes for use in systems which must meet ANSI/ASME B31.3 code requirements. • Special service stainless steel must be used for code applications. Check code limitations/restrictions on piping and components and the notes and footnotes applicable to the tables of allowable stresses in these codes relative to the standards for piping in the project specifications.
1		**Valves, Gates and Actuators**	• ANSI/AWWA C504-00 – *Rubber Sealed Butterfly Valves* • AWWA C507-99: *Ball Valves*, 150 mm through 1200 mm. • ANSI/AWWA C509-01: *Resilient-Seated Gate Valves for Water-Supply Service* • ANSI/AWWA C500-02: *Metal-Seated Gate Valves for Water Supply Service* • ANSI/AWWA C508-01: *Swing-Check Valves for Waterworks Service, 50 mm through 600 mm* • AWWA valve standards do not include 350 and 450 mm sizes • ANSI/AWWA C560-00: *Cast-Iron Slide Gates* • ANSI/AWWA C561-04 – *Fabricated Stainless Steel Slide Gates* • ANSI Standards B16.1 and B16.5 cover gate, globe, check, and ball valves up to approximately 400 mm for general water, air, steam, oil, and gas services • ANSI/ISA Standard S75.01.01 – *Flow Equations for Sizing Control Valves* (formerly ISA S75.01-1985 (R1995))
1		**Pumping Systems**	• Hydraulic Institute Standard ANSI/HI 9.8 (M123), Centrifugal and Vertical Pump Intake Design

1	**DESIGN CODES AND STANDARDS (Latest Editions) (Continued**	**Storage Tanks & Pressure Vessels**	Standards for tanks can be found in the many sources. The most common include: • American Water Works Association (AWWA) – standards for steel tanks for water storage • American Society of Mechanical Engineers (ASME) – boiler and pressure vessel (B&PV) codes for metal tanks (Section VIII) • American Society of Mechanical Engineers B&PV code for fiberglass tanks (Section X) • National Institute of Standards and Technology (NIST) – Voluntary Product Standard PS 15 for fiberglass reinforced tanks • American Petroleum Institute (API) – field-erected, shop-erected tank standards for a variety of tank types <<do we have any of these tanks?>> • National Fire Protection Association (NFPA) – standards for flammable liquids and gases, as required by fire and safety codes
	DESIGN CODES AND STANDARDS (Latest Editions) (Continued	**Lifting Equipment**	• The Crane Manufacturers Association of America (CMAA) specifications list design aspects of various types of bridge cranes. • ANSI MH 27.1 - *Specifications for Underhung Cranes and Monorail Systems* • ANSI/ASME HST 4M - *Performance Standard for Overhead Electric Wire Rope Hoists* • Hoist Manufacturer's Institute Standard Specification for Electric Wire Rope Hoists. • ANSI/ASME B30.10: *Hooks.* • ANSI/ASME B30.11: *Safety Standards for Monorails and Underhung Cranes.* • ANSI/ASME B30.16*: Safety Standard for Overhead Hoists (Underhung).*
1	**DESIGN REFERENCES AND RESOURCES**	**Manuals and Design Guides**	• AWWA M-11 – Steel Pipe – A Guide for Design and Installation • *Flow of Fluids through Valves, Fittings, and Pipe*, Crane Co. (Crane Technical Paper 410) • *Hydraulic Institute Engineering Data Book*, Hydraulic Institute 1990 • *Pumping Station Design*, Sanks, et al., 1998. • Fisher Controls and Regulators (Emerson) *Control Valve Handbook,* 3rd Edition • ISA *Handbook of Control Valves* • *Instrument Engineer's Handbook, Volume II, Process Control,* Bela G. Liptak, Editor, Chilton Book Company • CH2M HILL Design Guide for Ozone Systems© • CH2M HILL Design Guide for Granular Filtration Systems©

1	**DESIGN REFERENCES AND RESOURCES (Continued)**	**Hydraulic Modeling Tools**	• CH2M HILL's WinHydro© will be used to calculate general plant hydraulics and determine pipe and channel sizing. WinHydro is a steady-state model that describes systems that are downstream controlled. This model is utilized to determine water surface elevations for the main process tanks and channels and to verify that gravity flow can be accomplished through the plant at the maximum design flowrate. Minimum and average design flowrate scenarios will also be checked. • Applied Flow Technology (AFT) Fathom may also be used to determine pipe sizing. AFT Fathom is a software package that performs steady-state, incompressible, Newtonian fluid flow and energy analysis in an easy-to-use graphical environment for most piping systems (such as simple to complex networks, recirculating loops, heat transfer pipes and heat exchanges). Multiple- or single-pump systems can be modeled by assigning the required flows or pump curves for the pumps. Fathom can model control valves such as pressure control on either side of the valve, flow and pressure drop controls, and check valves. Fathom's built-in databases include many common liquids and gases, pipes, and many standard loss models for fittings, etc. In addition, Fathom can model sludges, utilizing coefficients from the Bingham Plastic flow model. Common applications include pipe sizing, pump selection, system operation, and control valve selection. • The Raw Water Pump Station (RWPS) and Deacon Booster Pump Station (DBPS) hydraulics will be modeled by Earth Tech. using their standard in-house programs.
1	**DESIGN PARAMETERS**		**Unit Process Design Parameters** • Refer to the respective Sections of the PDR **Test Pressures for Plant Piping Systems** • Raw water piping <> kPa • Filtered water piping <> kPa • Sludge transfer piping <> kPa **Hydraulic Factors of Safety** • In-plant concrete conduits – 1.5 • Process tanks – 1.5 • In-plant piping (RW, FE, SL etc.) – 1.0 • Non-structural process elements e.g. baffle walls, level control weirs – 1.0 • Process pumps – largest unit out of service for design flow (install additional pumps for Phase 2 capacity upgrades) • Process Overflows – 1.5 (each to be risk assessed)
1	**SERVICE CONDITIONS**	**General**	• Raw water pH 7.0 to 9.0 • Coagulation pH 5.5 to 6.0 • Finished water pH 7.5 to 8.0. • Post coagulation chloride levels < 50 mg/L

1	**SERVICE CONDITIONS (Continued)**	**Raw Water Pump Station**	• pH 7.0 to 9.0 • Chloride levels <50 mg/L
1		**Raw Water Header Piping**	• pH 7.0 to 9.0 • Chloride levels < 50 mg/L
1		**Flocculation & DAF**	• pH 5.5 to 6.0 • Chloride levels < 50 mg/L
1		**Ozone Contactors**	• pH 5.5 to 6.0 • Chloride levels < 50 mg/L • Ozone residual entering last cell of 0.5 to 1.0 mg/L • Intermittent hydrogen peroxide residual of 0.25 to 0.5 mg/L • Sulphate residual at outlet of 0.1 to 0.3 mg/L
1		**BAC Filters**	• pH 5.5 to 6.0 • Chloride levels < 50 mg/L • Sulphate residual of 0.1 to 0.3 mg/L
1		**Chlorine Contact Conduit (CCC)**	• pH 5.5 to 8.0 • Chloride levels < 50 mg/L • Continuous Free Chlorine residual at outlet of 0.25 to 1.0 mg/L
1		**Piping between CCC and Clearwell**	• pH 5.5 to 8.0 • Chloride levels < 50 mg/L • Continuous Free Chlorine residuals of 1.5 to 3.0 mg/L • Continuous Combined Chlorine (Chloramine) residual of 1.5 to 3.0 mg/L
1		**Clearwell, DBPS and UV Disinfection Facility**	• pH 7.5 to 8.0 • Chloride levels < 50 mg/L • Continuous Combined Chlorine (Chloramine) residual of 1.5 to 3.0 mg/L • Sulphate residual of 0.1 to 0.3 mg/L
1		**Washwater Recovery Tanks & Decant Pump Station**	• pH 5.5 to 6.0 • Chloride levels < 50 mg/L • Intermittent Free Chlorine residual of <> to <> mg/L • Sulphate residual of 0.1 to 0.3 mg/L
1		**Gravity Thickeners & Thickened Sludge Storage Tank**	• pH 5.5 to 6.0 • Chloride levels < 50 mg/L • Intermittent Free Chlorine residual of <> to <> mg/L • Sulphate residual of 0.1 to 0.3 mg/L
		Freeze-Thaw Lagoons and Lift Station	• pH 5.5 to 6.0 • Chloride levels < 50 mg/L • Intermittent Free Chlorine residual of <> to <> mg/L • Sulphate residual of 0.1 to 0.3 mg/L
		Sanitary Lift Station and Force Main	• pH 5.5 to 9.0 • Chloride levels < 50 mg/L • Intermittent Free Chlorine residual of <> to <> mg/L • Sulphate residual 0.1 to 0.3 mg/L

1	**CONSTRUCTABILITY CONCERNS**		• Installation and retro-fitting of large dia. piping into the Raw Water Piping and Filter Effluent galleries at a later stage if dual lines are required in future (but not installed initially). •
1	**CLIENT EQUIPMENT PREFERENCES AND ACCEPTABLE SUPPLIERS**	**Equipment Procurement**	Isolation and Control Valves • Automated and Manual Actuators (Rotork, pneumatic, chainwheels) • Pipe Coupling Systems (Victaulic, Dresser, Depend-O-Lok, Straube) • Flow Measurement (large and small dia pipes, open channel) • Coating and Lining of Piping and Fittings (dry and wetted) • Fusion-bonded epoxy Wall penetration/seal systems (e.g. link seals v.s. seal plates) • Large Submersible Centrifugal Pumps • Chemical Feed Pumps and Preparation Systems • Large Horizontal Centrifugal Pumps • Large Vertical Turbine Pumps • Process Blowers • Process and Instrumentation Air Compressors • Ozone Equipment (incl. LOX system/supply) • Gravity Filter Equipment (underdrains, troughs) • Large Chemical Storage Tanks (FRP, SST) • Gravity Thickener Equipment • Solids Handling Pumps • Onsite Sodium Hypochlorite Generation Equipment (Chlortec or WT) • DAF Equipment (Pre-purchase Bid) •

1	**LAYOUT & ACCESS**	**General**	• Designers should ask the following questions when developing layout drawings: ➢ Can the facility be built as shown? ➢ Is the facility easy and accessible to operate? ➢ Is the facility crowded? ➢ Can the facility be maintained conveniently? ➢ Is there a better way to lay out the facility? ➢ Can major equipment be easily accessed and removed if required? ➢ Can frequently removed equipment be easily moved through the plant? ➢ Can complete isolation of each process train be achieved? ➢ Are bypasses, parallel flow paths, and isolation provisions included for all unit processes and sub-systems? • Plant and area layouts were derived during the pre-design phase of the Winnipeg WTP, but require refinement during detailed design phase. • The major purpose of layout development is to ensure the efficient flow of materials, people, and vehicles around the site and within the buildings. All disciplines have input on the layouts, but the Area Lead Engineer has the primary authority. • Gallery layout is another important feature. Generous space allowances should be provided at major corridor junctions to minimize conflicts between crossing piping, trays, and

	LAYOUT & ACCESS (Continued)	**General (Continued)**	conduits. The gallery structure has a significant footprint that must be factored into the building layout. • The type and size of vehicles that require access for maintenance reasons must be determined. This information is required to allow design of the site roadway geometry and the bridges over channels. A functional site arrangement should be developed in which each building's function and the access requirements for maintenance vehicles are defined. Based on the functional arrangement, the ingress and egress of vehicles can be planned and the roadway system thereby developed by the Civil Discipline. • Pathways should be functionally planned in the same manner as the roadways. Above-ground pedestrian traffic should be considered with respect to an Operator's normal rounds and to pedestrian traffic between buildings. This assessment would account for instrument layout and above-ground equipment arrangement. Walkway planning would be integrated with structures that are provided as part of an operating piece of equipment (DAF clarifier basins, etc.) and those that are planned for pedestrian traffic between parallel tanks (i.e., Filters). Planning will minimize conflicts between vehicle and pedestrian traffic. In most case, pedestrian traffic would take precedence. Coordinate with Civil and Architectural Disciplines. • Emergency access planning must be performed. Ingress and egress routes for ambulances, fire trucks, etc., must be factored into the roadway and pathway design to ensure that the distance is not excessive between any point where accidents or fires could occur and a roadway accessible to the appropriate emergency vehicle. It is important get input on the layout from Fire Commissioner early in the design. Similarly, the authority having jurisdiction for the application of the building code should be brought into the discussion to ensure that the understanding of the code is not in question. Coordinate with Architectural and Building Services Disciplines. • In addition, building codes generally stipulate the maximum spacing between access points between the surface and the below grade structures such as tunnels, pipe galleries and chases. These access points must be factored into the walkway and roadway layout. Coordinate with the Architectural Discipline

1	**LAYOUT & ACCESS (Continued)**	**Process Equipment and Tanks**	• Typically, one type of equipment will be chosen as the basis of design. This 'make' or 'model' is referred to as the "design standard". Layout should be based on this selection. Where other manufacturer's products are also suitable, the layout should be checked to ensure that the arrangement does not preclude the use of the alternatives. • All required space and routes of equipment removal/replacement/maintenance shall be provided for in the layout drawings. • Mount equipment and panels upon equipment house-keeping pads to protect them from wash down. • The minimum clearance on all sides around rotating equipment over 10 hp (7.5 kW) should be 1.2 metres. • Leave at least 1.2 metres of clearance between the outermost extremities of adjacent pieces of equipment or between a wall and a piece of equipment. • Clearance in front of any other equipment face or panel requiring maintenance should be at least 1.2 metres. • Pressure vessels should be at least 0.6 metres from the back wall and 1.0 metres apart. Sufficient space in front of the vessel should be provided for the face piping plus 1.2 metres. • For pumps, compressors, and other rotating equipment where parallel units are provided, the orientation of the drive and the rotation should be identical. • Pumps used for sludge/solids pumping should be arranged to minimize the distance and number of bends through which the liquid must be conveyed to the pump suction. • Provide adequate headroom for removal of vertical turbine pumps, and/or specify shafts, shaft enclosure tubes (where applicable), and columns in specific length sections that are removable within the building/lifting equipment constraints. • Provide ladders and hatches to access and remove equipment. • 'Motorized' hoists, monorails, or cranes should be provided where equipment component weights exceed 900 kg (2000 lb) and/or when frequent lifting for maintenance is necessary. • Provide adequate lifting headroom for all equipment. An allowance for sling length or lifting (spreader) beams between equipment lift points and crane or hoist hook also needs to be included (consult equipment manufacturers). • Provide lifting eyes, in accordance with the Standard Details, above all equipment not otherwise provided with lifting means. • Place wash-down drain points in logical areas to facilitate clean-up and pipe flushing. Provide PSW hose bibs so that the maximum length of hose required is 15 metres.
1		**Piping and Valves**	• Locate piping so that it is not a tripping hazard, a head-banger, or a barrier to equipment access. • Minimal piping should be located above blowers, compressors, or pumps to facilitate lifting/removal. • In general, lay out piping close to walls where it can be supported easily, particularly in spaces with high ceilings.

	LAYOUT & ACCESS (Continued)	**Piping and Valves (Contintued)**	• If piping must be run close to a wall, but not supported from it, leave at least 0.6 metres of clearance between the outermost pipe flange and the wall. • To permit purging of air from the pipeline while it is being filled with water, locate a manual vent valve on the highest point of every pipeline to be filled with liquid or which is to be hydrostatically tested. • To permit water drainage, locate a manual drain valve on the lowest point of every pipeline. • Pipe supports and seismic bracing are generally not shown on the layout drawings. Verify, however, that adequate space is available for installation of these supports. • Provide flexible connections/couplings to permit easy assembly and disassembly of piping and connections to equipment. • When laying out piping, keep the placement of anchors and expansion joints in mind. These must be located on the drawings. • If piping reducers are required on the suction side of a pump, provide eccentric reducers that are flat on top (FOT). • Wall penetrations should be perpendicular to the wall. • Make an effort to keep valves within operator reach (below 2.4 metres). For any valve over 2.4 metres above the operating floor, provide a chain operator or actuator. • Do not place swing check valves in vertical piping runs. • Install an easy disassembly coupling or pipe joint within four diameters of all valves. • Provide thrust restraint for sleeve and other couplings that are not capable of internal thrust restraint. • Allow ample space for valve and gate actuators. • Provide adequate clearances for rising stem valves and gates. • Provide sufficient straight runs for flow meters and other I&C elements sensitive to flow patterns. •
1	**PUMPING EQUIPMENT**	**Pumping Equipment Selection <<Acceptable vendors to be deleted if WWD have preferred manufactuers /suppliers for specific equipment, as listed above>>**	**<u>Centrifugal Pumps</u>** Centrifugal pumps are best used to move large flows at low to moderate heads. Depending upon the impeller configuration, centrifugal pumps can move liquids containing a variety of solid material. Centrifugal pumps, however, do not pump viscous fluids very well. Also, flow from a centrifugal pump is strongly affected by the system pressure (suction and discharge), making it a poor selection where a precise flow rate is required (without flow control) • **Non-Clog Dry Pit Centrifugal** Use non-clog dry pit centrifugal pumps for pumping sludges and for dewatering. These pumps shall handle solids up to a sphere size of 75 mm. • **Non-Clog Submersible Centrifugal** Includes recessed impeller, screw centrifugal and chopper styles. Typically used for standard sumps, or low-head sludge and slurry transfer. Minimum sphere passage is 100 mm. Acceptable

	PUMPING EQUIPMENT (Continued)	**Pumping Equipment Selection (Continued)**	vendors include Flygt, Flowserve, KSB and Cornell. • **Horizontal End Suction Centrifugal** Use horizontal end suction centrifugal pumps for pumping or circulating clear or reasonably clear water, such as process samples. Non-metallic (FRP) versions are used to transfer chemical solutions and other clear corrosive liquids. Acceptable vendors include Goulds and Fybroc (non-metallic). • **Horizontal Split-Case** Use for pumping or circulating clear or reasonably clear water. Use only where an end suction centrifugal pump is not adequate, as the cost of split-case pumps is higher. Acceptable vendors include Flowserve and Aurora. • **Vertical Wet Pit Centrifugal** Typically used as sump pumps for pumping mild slurries and clear or reasonably clear liquids. Also used for pumping chemical solutions from storage tanks or secondary containment sumps. • **Non-Metallic Vertical** Typically used for chemical or corrosive sump applications, constructed of FRP. Acceptable vendors include Goulds and Fybroc. • **Vertical Turbine** Also includes vertical mixed-flow and axial-flow pumps. Typically used for pumping clear or reasonably clear water such as; raw water (low lift), BWS, filter influent, surface wash pumping; and for plant service water supply and fire pumps. • **Magnetic Drive Centrifugal** Typically only used for chemical transfer pumps. To prevent leakage, magnetic drive pumps have no shafts (or seals), resulting in low efficiencies and higher horsepower requirements. **<u>Positive Displacement Pumps</u>** Positive displacement pumps are used for low to medium flow rates at low to high heads. Positive displacement pumps handle viscous fluids well, but can be susceptible to abrasion. Flow from a positive displacement pump is essentially independent of system pressure, making it a good choice when a precise flow rate is required. Coupled with a variable speed drive, some positive displacement pumps can handle a much wider pressure/flow range than any centrifugal pump. Positive displacement pumps tend to be more expensive than centrifugal pumps, and usually have higher maintenance requirements. • **Progressive Cavity** Typically used for non-abrasive sludges, slurries and viscous liquids such as liquid polymer transfer and metering. For sludge pumping applications the maximum speed should be limited to 150 rpm. PC pumps shall be complete with stator over-temperature sensor/switch. Acceptable vendors include Moyno and Seepex. • **Chemical Metering Gear Pumps** Typically used for chemical metering where either high accuracy,

	PUMPING EQUIPMENT (Continued)	**Pumping Equipment Selection (Continued)**	off-gassing or significant flow turn-down are issues. While they are more robust than diaphragm and peristaltic styles they have higher capital costs. Specify as magnetically coupled and driven to prevent leakage. Ensure to check wetted part material compatibility against pumped fluid. Acceptable vendors include Micropump, Pulsafeeder or Tuthill. • **Peristaltic** Typically used for chemical metering. More robust than solenoid or diaphragm metering pumps. Consider for use on the hydrogen peroxide system due to them having a range of compatible non-metallic wetted parts (tubes). Acceptable vendors include Watson-Marlow-Bredel, and.Verderflex. • **Rotary Lobe** Typically used for same applications as progressive cavity. Rotary lobes consume less footprint and can be less expensive compared with progressive cavity in terms of maintenance. Acceptable vendors include Vogelsang and Boeger.
1	**PUMPING EQUIPMENT**	**Pumping Equipment Specification** **Pumping Equipment**	**<u>Pump Speeds</u>** • Centrifugal pump speeds should not, as a rule, exceed 1,750 rpm in water and waste pumping applications. Exceptions are services such as single-stage pumping against very high heads (90 to 150 m). • Slower speeds are desirable where non-clog centrifugal, vertical turbine, mixed-flow, and axial-flow pumps are used, particularly for 100 hp sizes or larger. Speeds of 1,170 rpm, 870 rpm, and lower are not unusual for large diameter pumps. Slower speed pumps are usually larger than pumps operated at 1,750 rpm, however, and therefore cost more. • Where slow speed (580 and 700 rpm) or medium speed (1,170 and 1,750 rpm) horizontal mixed-flow and axial-flow pumps do not provide the head required, vertical multistage units of the same types shall be considered. Two- and three-stage units are available in vertical mixed-flow and. axial-flow pumps. • Operating speeds for positive displacement pumps vary depending on the pump type and fluid being pumped. Check with pump manufacturers for recommended maximum pump speeds for specific services. **<u>Pump Shaft Seals and Packing</u>** • Generally, pumps should be furnished with mechanical seals. • Single seals will suffice for most applications. Consider double seals for sludge and chemical services, however magnetic drives are preferred for chemical services. • Packing may be considered for a few applications (not common). • External flushing with seal water is required for all services other than clean water. • **Mechanical Seals** Seals will be high quality, split mechanical, cartridge (refer to standard specifications). • **Packed Stuffing Boxes** Specify five rows (minimum) of graphite-impregnated braided

	(Continued)	**Specification (Continued)**	non-asbestos packing and split glands. If external flushing is required to flush abrasives into the pump, specify lantern ring. Consider packed stuffing boxes only when all the following conditions are met: - Pump discharge pressure less than 50 psig. - Pump speed less than 1,750 rpm. - Pump shaft diameter of less than 1-1/2 inches. • **Seal Water Pressure** Seal water pressure, whether for mechanical seals or packed stuffing boxes, shall be approximately 3 to 5 psig higher than the stuffing box pressure. Consult pump manufacturer for specific stuffing box pressure. For a rough approximation of stuffing box pressure, use a minimum of one-half the pump differential pressure plus the pump suction pressure. A CH2M HILL standard detail is available for the seal water connection to a pump. **Bearing Life Ratings** • Bearing Life Rating (B-10 or L-10) is defined as the number of hours that 90 percent of a group of bearing will complete or exceed, at a rated speed and loading, before the first evidence of fatigue develops. Average life is statistically five times the rating life. • The minimum anti-friction (rolling element) bearing rating life (ABMA L-10) for this project is to be specified as 100,000 hours for 24-hour continuous duty and maximum reliability. • Rating life is not defined for plain journal type bearings. **Bearing Lubrication** • Specify grease lubrication for ball and roller bearings, both guide and thrust. • Grease-lubricated bearings shall be fitted with addition and relief fittings. • Consult the manufacturers for details of lubrication systems for large rotating equipment. **Couplings** • Couplings shall either be Falk, Fast spring-grid, or gear type flexible coupling with coupling guard for horizontal pumps and close-coupled vertical pumps. • Spacer couplings shall be used for back pullout-type pumps and pumps with mechanical seals. • Vertical turbine pumps with hollow shaft motors shall be furnished with "non-reverse couplings" to protect the pump and motor against backspin during shutdown and power failure. • Pumps with adjustable-speed drives which have solid shafts should be furnished with a flanged, adjustable coupling. **Shaft Guards** • Shaft guards shall be provided on vertical non-clog pumps around any exposed intermediate shafting that presents a safety hazard to operating personnel. • The shaft guard shall cover the shafting from the top of the pump to a minimum height of 2.1 metres above the floor or other working surface, or as otherwise required by local
	PUMPING EQUIPMENT	**Pumping Equipment**	

	(Continued)	**Specification (Continued)**	safety codes. • Two-piece cage guards, split for easy disassembly, shall be provided. **Materials of Construction** • Pump materials shall generally be iron construction with bronze fittings. • There may be certain installations that require selection of corrosion or abrasion resistant materials, such as chemical feed or sludge pumping. Designers shall refer to and review the PDR in making material selections. **Sump and Wet Well Design** • The Hydraulic Institute Standard ANSI/HI 9.8 shall be utilized as a reference and guide in the design of sumps and wet wells. Adequate pump suction approach velocities and submergence shall be provided. • Sufficient wet well volume to provide system control stability is required for all pump installations. Improper wet well sizing can result in serious control problems. Consider the following: ➢ Wet well surface area should be sized to prevent excessively rapid motion (rising or falling) where continuous level control is being considered. Under any viable loading changes, a speed of less than 75 mm per second is recommended. ➢ Another rule of thumb recommended by the Hydraulics Institute is to design the wet well so that the usable control volume (in litres, volume between top and bottom of the control) is at least two times the maximum station pumping capacity (in lpm). ➢ If it is desired to crowd either of these two criteria, a dynamic analysis is recommended. ➢ Wet well volume for constant speed pumps should be sized to prevent pump cycling (starting) more frequently than can be facilitated by its drive motor. Refer to the Electrical Discipline Design Basis for appropriate minimum cycle times (start to start). ➢ The level measurement location point should be chosen to be in a region of low turbulence, wave action, or vortexing, or provided with a stilling well, to avoid a widely fluctuating or unstable level signal.
1	**PUMPING EQUIPMENT (Continued)**	**Pumping Equipment Hydraulic Design** **Pumping Equipment Hydraulic**	• Hydraulic calculations shall be prepared for all pump applications. • Prepare single-line isometric schematics from pump suction piping origin to the point of system discharge for development of the calculations. This schematic shall show line sizes, dimensions, fittings, and piping materials. • Prepare plots of system curve from the system information and impose pump curves on these plots indicating pump operating points for various pump speeds and system head conditions. Indicate on these plots the design operating points and envelope for possible inclusion in the pump specification. • Conversion of pump operating performance for fluids having viscosities different than water shall be determined by the

		Design (Continued)	pump manufacturer. • Selected pump operating points shall be centered near the pump best efficiency point at the design condition. A rating point selected to the right of best efficiency flow will allow higher efficiency at reduced flow and speed. Caution shall be exercised in selecting pump operating points at the extremes of the pump operating curve due to possible excessive pump shaft radial loading and reduced bearing life and possible shaft failure. • Care shall be exercised in providing adequate overlap of pump performance when multiple parallel pump installations are provided. Proper pump sequencing requires that pumps have sufficient performance overlap to allow transition adding or dropping pumps in operation. • Net positive suction head available (NPSHA) is the system energy available to drive flow into the pump suction at the impeller eye. Specific design characteristics determine the net positive suction head required (NPSHR) by a given manufacturer's pump. NPSHA must exceed the NPSHR of the pump(s) under consideration. • Keep suction lines short and straight. Check the NPSHR of several pump manufacturers. Design engineer must provide adequate NPSHA plus a margin of safety because most pump manufacturer's NPSHR curves are based on the pump operation at 3-percent deterioration in head when operating on clean, clear water at the NPSHR value. This is the basis of pump testing for NPSHR in Hydraulic Institute standards. • NPSH calculations for centrifugal and vertical pumps must comply with ANSI/HI 9.6.1, *American National Standard for Centrifugal and Vertical Pumps for NPSH Margin*. The standard provides calculation methods and safety factors. The minimum safety factor for positive displacement pumps such Gear Pumps and Progressive Cavity is 30 percent (i.e., NPSHA/NPHSR =1.3).
1	**AIR COMPRESSORS**	**General**	• The information below is presented to serve as a guide in selecting compressors. • In this Design Basis, only compressors in the size ranges commonly used for plant air requirements are discussed. • Pressure ranges commonly used vary from 550 to 860 kPag..
	AIR COMPRESSORS (Continued)	**Compressor Selection** **Compressor Selection**	**<u>Reciprocating Compressors</u>** • Reciprocating compressors commonly used for plant air generation cover an approximate range from 0.2 kW (0.25 hp) with an output of 1.7 m3/h (1 cfm) to 1,119 kW (1,500 hp) at an output of 10194 m3/h (6,000 cfm) for a 69 0kPag (100 psig) discharge pressure. • Reciprocating units are positive displacement compressors. The reciprocating compressor accomplishes this by using a piston within a cylinder as the compressing and displacing element. • The compressor is considered single acting when the compression is accomplished using only one side of the piston. This type of compressor is normally air-cooled.

		(Continued)	• A compressor unit using both sides of the piston is called double acting. This type of compressor is normally water-cooled. • The compressor uses a number of automatic spring-loaded valves in each cylinder that open only when the proper differential pressure exists across the valves. Inlet valves open when the pressure in the cylinder is slightly below the intake pressure. Discharge valves open when the pressure in the cylinder is slightly above the discharge pressure. • A unit is considered to be single stage when the entire compression is accomplished with a single cylinder or a group of cylinders in parallel. • Many applications involve conditions beyond the practical capability of a single compression stage. Therefore, for practical purposes, most plant air reciprocating compressors over 100 hp are built as multistage units in which two or more steps of compression are grouped in series. • The air is normally cooled between the stages, with a water-cooled heat exchanger, to reduce the temperature and volume entering the following stage. • Advantages: ➢ Proven dependability ➢ Most efficient at full load ➢ Best part load efficiency ➢ Largest size range (capacities and pressures) • Disadvantages: ➢ Unbalanced forces ➢ Highest first cost ➢ May require air dryers and oil removal filters ➢ High foundation cost to isolate reciprocating forces ➢ Greatest installation cost ➢ Large number of maintenance parts ➢ High maintenance cost **<u>Rotary Compressors</u>** • Rotary compressors commonly used for plant air production cover an approximate size range of 7-1/2 hp @ 30 cfm to 500 hp @ 2,500 cfm for a 100 psig discharge pressure. • The most common unit is the helical or spiral lobe screw compressor, which is a positive displacement, oil-flooded, single-stage compressor. These units consist of two rotors within a casing where the rotors compress the air internally. There are no valves. These units are basically oil-cooled (with air- or water-cooled oil coolers) where the oil seals the internal clearances. • The most efficient units limit the rotor tip speed to about 20 to 30 m/s (4,000 to 6,000 feet per minute) and use unsymmetrical rotor profiles. To achieve this optimum rotor tip speed, built-in speed-increasing or speed-reducing gears are used sometimes to achieve the most efficient rotor speed for a given rotor diameter. • Other designs provide for direct drive of the rotors with 1,750- or 3,500-rpm motors, achieving lower manufacturing costs at some sacrifice of efficiency.
	AIR COMPRESSORS (Continued)	**Compressor Selection**	

		(Continued)	• The rotary compressor is a very simple compressor with few moving parts. It operates in the following way: ➢ Air passes through an air intake filter and across the intake throttle valve into the compressor. ➢ Oil is injected into the casing to seal the air passage and cool the air. The air-oil mixture is compressed to about 100 psig and travels to an air receiver/oil separator where almost all of the oil is removed. ➢ The air then passes through a built-in air- or water-cooled after cooler and check valve into the plant. The recovered oil is cooled, filtered, and returned to the compressor. • Advantages: ➢ Lowest first cost ➢ Lowest installation cost ➢ No unbalanced forces ➢ Few maintenance parts ➢ Easy to relocate ➢ Low foundation cost • Disadvantages: ➢ Least efficient at partial load ➢ Oil must be changed frequently ➢ Noise on some units ➢ May require air dryers and oil removal filters ➢ Relatively high maintenance cost **Centrifugal Compressors** • Centrifugal compressors used for plant air production range in size from approximately 300 hp with a capacity of 1,250 cfm, to 3,500 hp with a capacity of 15,000 cfm for a 100 psig discharge pressure. • The centrifugal compressor is a dynamic unit that depends on the transfer of energy from a rotating impeller to the air. The rotor accomplishes this by changing the momentum and pressure of the air. This momentum is converted to useful pressure energy by slowing the air down in a stationary diffuser. • This is an oil-free compressor. The oil-lubricated running gear is separated from the air by shaft seals and atmospheric vents. • All modern centrifugal plant air compressors use a bull gear that, in turn, drives three or four impellers or stages. They work basically as follows: ➢ Air passes across a built-in throttle valve or inlet turning vanes to the first-stage impeller. The impeller imparts velocity, which is converted to pressure by a built-in diffuser. ➢ The air then passes through a built-in water-cooled intercooler where it is cooled to within 15 degrees of the cooling water inlet temperature. The moisture is removed in a moisture separator and drained through a trap.
	AIR COMPRESSORS (Continued)	**Compressor Selection**	➢ The compressed air then repeats the same process through the second, third, and fourth stages. The air

		(Continued)	leaving the fourth-stage after-cooler passes across a built-in check valve and into the plant. ➢ If the plant demand is less than the surge capacity, the unused air passes through a blow-off valve and a silencer to the atmosphere. • Advantages: ➢ Lowest cost large compressor greater than 2,500 cfm ➢ Oil-free air ➢ Packaged designs common at low installation cost ➢ No unbalanced forces ➢ Minimal maintenance ➢ Low foundation cost • Disadvantages: ➢ More complex control system ➢ Additional protective devices advisable **Recommendations** • Before selection of a compressor or compressors can be made, several basic decisions must be made. These include: ➢ A determination of air capacity and pressure requirements ➢ The increments of compressor size to be added ➢ The type of compressor: • Reciprocating, rotary helical lobe screw, or centrifugal • Air-cooled or water-cooled • Lubricated or non-lubricated cylinders • To narrow the field of choice, only air-cooled reciprocating and rotary units generally are considered under 1,000 cfm. • For heavy-duty continuous operation, crosshead-type reciprocating compressors should be reviewed in this range. • Above 2,000 cfm, centrifugal compressors should be included in a review. In making a selection, careful analysis should include: ➢ First cost ➢ Installed cost ➢ Cost of required accessories ➢ Space requirements ➢ Foundation requirements ➢ Power consumption, at both full and partial load ➢ Availability and cost of cooling water ➢ Oil-free air requirements ➢ Oil consumption ➢ Duty cycle ➢ Local or central location ➢ Caliber of maintenance and operating personnel ➢ Carbon or Teflon dust-free air requirements
1	**PROCESS AIR BLOWERS** **PROCESS AIR**	**General** **General**	• Low-pressure compressors used for granular filter air scour are commonly called blowers. • Acceptable blowers for Winnipeg WTP are limited to two-centrifugal blowers or lobed rotary units, preference being depending on the application.

	BLOWERS (Continued)	**(Continued)**	• Consider multistage blowers for use in filter air-scour. Acceptable vendors include Lamson and Hoffman • HVAC and Odour Control System (if applicable) blowers are covered by the Building Mechanical Design Basis
	PROCESS AIR	**Blower Selection**	**<u>Centrifugal Blowers</u>** • Centrifugal compressors are the most important of the dynamic machines, having an impeller similar to a centrifugal pump. • Impellers can be arranged singly or in multiple units for higher discharge pressures. • Centrifugal blowers usually take in air at the impeller eye and accelerate it radially. • At a constant speed, a centrifugal compressor delivers practically constant discharge pressure over a considerable range of inlet capacities. • If demand decreases below rated flow, the compressor continues to deliver compressed gas at about the same pressure until a point is reached where surge occurs. • Surge is an unstable condition, occurring usually at about 50 percent of rated flow. The surge point is sometimes called the stability limit. As demand decreases, a point is reached where backpressure temporarily exceeds the pressure ratio developed by the compressor, and a breakdown in flow results. This immediately allows backpressure to go down, regular compression is resumed, and the cycle is repeated. • Varying the speed will permit lowering the surge point at reduced output pressures, or use of adjustable inlet guide vanes will further reduce the surge point. • Also, to ensure stable operation, a minimum pressure rise (normally 0.5 psig) from design point to surge point should be specified. • Advantages: ➢ Lowest maintenance cost ➢ Low installation cost ➢ No inertia forces, small foundation ➢ Less noisy operation ➢ Oil-free air ➢ Low foundation cost • Disadvantages: ➢ Limited stable operating range ➢ High vibration may require rebalancing of wheel ➢ Reduced volume will result from excessive backpressure buildup due to a decrease in permeability filter media **<u>Rotary Blowers (not used for filter air-scour)</u>** • Lobed-rotor compressors have two rotating elements that revolve in opposite directions in a chamber. Usually, the lobed rotating elements have two projecting lobes, but some have more. • Ideally, the impellers do not touch one another, a small amount of clearance being maintained by timing gears. The clearances allow some air to escape back to the suction side of the compressor.

	BLOWERS (Continued)		• Defined as "slip," this leakage is a constant for any given compressor at a given pressure. It is expressed in revolutions per minute since it is found by dividing leakage volume per minute by the displacement per revolution. • Because slip is constant, these compressors should be operated at the highest recommended speeds to obtain maximum volumetric efficiency. • Advantages: ➢ Lowest first cost ➢ Lowest installation cost ➢ Oil-free air ➢ Constant pressure with varying speed ➢ Easy metering by rpm count • Disadvantages: ➢ Higher maintenance ➢ Noisy operation
1	**STORAGE TANKS & VESSELS**	**Materials of Construction**	• Typical tank materials for WTPs include concrete, stainless steel, steel (rubber lined, plastic lined), aluminum, plastics (PVC, FRP, PVDF, PP), and ductile-iron (cement lined, glass lined) for process areas and mild steel, copper, cast iron, and plastics for non-process areas. • General guidance on selection of piping and compatible tank materials for the chemicals proposed for the Winnipeg WTP are discussed in the PDR Section 20. • The storage tank material is determined based upon the characteristics of the liquid or gas that is to be stored. The liquid or gas that is stored should not corrode or deteriorate the storage tank over time.
1	**STORAGE TANKS &**	**Tank Features** **Tank**	**General** There are a number features that should be considered when designing/specifying tanks. The codes and standards listed above provide guidance in tank design & construction, often including tank features. The information presented below is to supplement what is available in these documents. **Nameplates and Code Data Plates** • ASME codes require application of a data plate to a pressure vessel. This specifies code information such as the appropriate code symbol, name of manufacturer, working pressure, design temperature, serial number, and year built. API (and the other standards) provides similar requirements. • In addition, a nameplate should be provided on each tank with the following information: ➢ Equipment number ➢ Process liquid or gas ➢ Contract number or purchase order number ➢ Capacity of vessel ➢ Pressure/temperature rating (if not provided on other data plates) • Nameplates should be made from 16-gauge stainless steel or aluminum, with 1/4-inch die-stamped lettering.

	VESSELS (Continued)	**Features (Continued)**	**Manways** • Every tank should have a way to enter the vessel for periodic inspection, unless the vessel is quite small (less than 450 mm dia. typically) when hand holes are acceptable for inspection and cleaning. • Depending on dimensions of the tank, manways to be provided at the top of the tank and the side of the tank near the base. • Manways should meet the applicable OH&S standards for size and function. In a practical sense, this means round manways of at least 500 mm in diameter, and oval manways of at least 300- by 400-mm. A commonly used manway size is a circular 600-mm-diameter unit with a bolted cover and gasket. • Many manways have davits or hinges provided, especially if the pressure rating of the vessel dictates a heavy flange, or if the flange is located such that it is inconvenient to unbolt and bolt up the cover each time. • Most manways have flat covers, but hemispherical heads are used for high pressure situations. **Support Saddles** • Horizontal tanks require some means of support, and support saddles are commonly used to provide this function. Often, the saddles are formed out of concrete and provided as part of the foundation. In other cases, the saddles are furnished with the tank itself and have bearing pads to match with the foundation. • In either case, protection must be provided to the tank wall. With either welded saddles or concrete saddles, wear plates (or doubler plates) should be provided on the tank. The advantage to these wear plates is twofold. First, welding and/or support contact does not interfere with the tank wall material, or compromise the pressure design. Second, the material choice for the saddle system does not need to be the same as the tank wall, and the transition between dissimilar metals can take place at the wear plate. • Concrete saddles usually have arc-shaped inserts provided to mate with the wear plate on the tank. Coordination of the radii of the wear plate and the saddle dimensions is important to avoid poor fit of the final assembly. **Vent Lines and Overflows** • All atmospheric tanks should have vent lines provided, often with some kind of insect screen or desiccant breather to protect tank contents. Tanks containing fuels often have flame arresters provided on the vent connection. • The vent line should run outside, or into a suitable ventilation system for exhausting fumes and moisture. Vent lines should be sized to prevent collapsing (imploding) the tank during pump out or drainage activities. • Just as important for most tanks is the overflow line. The overflow line should prevent surcharging of the tank contents out of the vent line or other nozzles if and when the tank is over-filled. The overflow line is usually routed to a
	STORAGE TANKS &	**Tank**	

	VESSELS (Continued)	**Features (Continued)**	drain sump or secondary containment system, where the contents can be safely and efficiently handled. • Where two or more tanks are used for storage of a single chemical, the overflow lines will be combined such that one tank will first overflow into the next tank before it overflows into the secondary containment system. • Overflow lines should be fitted with fume traps (where applicable) to prevent venting off-gases into the room. **Ladders and Platforms** • Storage tanks and silos need methods of access to the tank manways, inspection doors, top-mounted relief valves and level sensing instrumentation, and other tank accessories. This often requires the use of platforms and ladders on tanks. • Platforms and ladders should be designed to meet the applicable OH&S standards, and should be suitably sized for the work activity they support. Attachments should be made to the tank to securely hold platforms and ladders in place. These attachments should be made using doubler plates on the tank, to avoid direct connection of support steel to the tank wall. **Safety and Relief Valves** • ASME defines safety valves as a pressure relief device that opens rapidly by inlet static pressure. The common application of safety valves is on steam and air service, where a large volume of gas is vented to effect a reduction in pressure. Air saturator vessels would be such an application. • A relief valve is defined as a pressure relief device that opens in proportion to the internal pressure. Relief valves are used on liquid systems, where a small amount of liquid will generally effect a reduction in pressure. • ASME requires some form of pressure relief device on a code certified tank properly selected for the service. An alternative to a safety or relief valve is a rupture disc (or blast gate), which also responds to internal pressure, and rapidly releases pressure (without re-closing). • Connection(s) on tanks for these devices should consider the following: ➢ Relief valves/rupture discs should be as close as possible to the vessel to maintain the relief pressure set point. ➢ Pressure reaction at the valve should be anticipated, especially with discharge piping connections. Often the slip-fit, “umbrella” type discharge connection is appropriate. ➢ Discharges of rupture discs can be dangerous and should be situated to avoid contact with personnel. Also, some form of protection should be given the rupture disc element (from the outside) to avoid accidental puncture or damage. ➢ Sulfuric acid storage tanks will include low-pressure “conservation” vents to allow air into the tank at vacuum conditions of approximately 300 mm water column and allow air to discharge at approximately 500 mm water column. This will minimize the respiration
	STORAGE TANKS &	**Tank**	

	VESSELS (Continued)	**Features (Continued)**	of air during periodic temperature changes and between tank filling and drawing down. The vacuum vent will be fitted with a desiccant air dryer to remove much of the atmospheric air moisture entering the tank to reduce the potential for weak acid corrosion in the gas space above the liquid surface.
1	**PLANT PIPING SYSTEMS**	**General**	• Plant piping includes yard piping, which may be entirely designed and specified outside of the mechanical discipline. • Yard piping of site-related utilities such as drainage systems and water distribution is discussed in the Civil Discipline Design Basis. • Plant piping of process services and mechanical utilities in the yard also requires Civil Discipline coordination and consideration for earth loads and traffic loads.
1		**Pipe Materials and Applications**	• A preliminary Piping Schedule indicating piping services planned for the Winnipeg WTP can be found in Section 20 of the PDR. • The schedule will be updated as the Detailed Design progresses to include identifying symbols (abbreviations) for service/commodity, material of construction, coatings, linings, and test pressures to be used for these services. • The finalized schedule will ultimately become the Piping Schedule included in the construction specification documents. • Polyvinyl Chloride (PVC) piping shall not be used where it may be subject to mechanical impact damage, buried services or where heat tracing is required. Also note that PVC piping is very brittle at low temperatures. • For Hazardous Chemical Piping; piping, labeling, personnel protection, and pipe location; shall conform to Provincial and local codes. • Hazardous Chemical piping and tubing between structures and building areas shall be run in containment piping (double walled) with leakage monitoring wells formed by a containment tee branch and drip-leg below the low point of piping runs.
1		**Pipe Joints and Couplings**	The following types of pipe joints and coupling systems shall be shown on the drawings and specified in order to provide design uniformity. **Black Steel Pipe (Epoxy Lined/Coated)** • < 50 mm – screwed or socket-welded • > 65 mm – grooved end, butt-welded, or flanged **Stainless Steel Pipe** • **Stainless Steel Tubing** • **Ductile Iron Pipe** • > 100 mm: grooved end, flanged, mechanical joint, or proprietary restrained joint **Galvanized Steel Pipe**

	PLANT PIPING SYSTEMS (Continued)	**Pipe Joints and Couplings (Continued)**	• < 50 mm – screwed • > 65 mm – grooved end or flanged **Copper Pipe and Tubing** • general service **-** socket joint with 95-5 wire solder **Polyvinyl Chloride Pipe** • solvent welded, screwed, or flanged **Buried and Submerged Piping Joints** • Do not use grooved end joints on any type of buried or submerged piping • Buried ductile iron pipe – mechanical joint, push-on joint, or proprietary restrained joint ends • Buried ductile iron pressure piping – thrust blocked, if practical, or proprietary restrained joint ends • Buried steel piping – coupled with flexible sleeve-type mechanical couplings, bell and spigot joints with retained rubber gaskets, or welded joints. Mechanical couplings and bell and spigot joints in pressure piping shall be provided with thrust ties unless thrust-blocked. • Buried joints on ferrous metal piping – bonded for cathodic protection application, as indicated in the Civil Design Basis. **Grooved End Piping Joints** • Grooved end joints (Victaulic or Anvil International, Inc., Gruvlok) are to be shown for all exposed piping 4 inches and larger in ductile iron systems • Grooved end joints (Victaulic or Anvil International, Inc., Gruvlok) are to be shown for all exposed steel piping larger than 2 inches, except fuel oil, propane, natural gas, compressed air and carbon dioxide shall be screwed, butt-welded, or flanged. • For those services that exclude grooved end joints, the specific type of joint to be used shall be specified in the piping specification data sheet and shown/noted on the drawings.
1	**PLANT PIPING**	**Piping System Hydraulics** **Piping**	**Modeling and Calculations** • Refer to Hydraulic Modeling Tools above, for methods/software to be used for calculating energy gradeline and losses for process 'water' piping. • Fluids other than water (s.g. 1.0) must use a hydraulic loss calculation method, which considers the fluid properties of specific gravity and viscosity. These parameters are used to determine the Reynolds Number of the flow and the appropriate Darcy friction factor for the type of pipe and the pipe size. • A good resource for these methods is the *Crane Technical Paper No. 410.* The Crane Technical Paper includes methods for calculating fitting and valve losses and for compressible fluids. The AFT Fathom software includes fluid properties for many common fluids other than water and the user may define properties for specific aqueous solutions of chemicals used in this project (e.g. polymers). • Sludge flows with solids concentrations < 2% can be

	SYSTEMS (Continued)	**System Hydraulics (Continued)**	adequately modeled as water using the Darcy or Hazen-Williams equations. • Due to the complex and varying rheological properties of sludge with solids concentrations > 2%, calculating pressure drop is more challenging than for Newtonian liquids like water. Sludge piping calculations should be supervised by persons experienced in designing sludge conveyance systems. The reader is refered to Chapter 19 of *Pumping Station Design*, Sanks, et al., 1998, for discussion on determining friction losses in sludge piping. • Designers are cautioned to use actual pipe inside diameters, especially for small piping and tubing. Different pipe materials in the same nominal size usually have different actual inside diameters. The effect of pipe aging should also be accounted for in the calculation as well (aged C factor). **Pipeline Velocities** • **Gravity Pipelines and Channels** ➢ Normal: 1.0 to 1.5 m/s ➢ Maximum velocity: 2.5 to 2.8 m/s ➢ Minimum velocity: 0.5 m/s (where floc present) • **Pressure Pipelines** ➢ Normal: 1.5 to 2.5 m/s ➢ Maximum: 3.0 to 3.5 m/s ➢ Minimum liquid velocity: 0.5 to 1.0 m/s • The maximum and minimum liquid velocities noted above may be exceeded occasionally. However, this is the design range to be used for normal maximum and minimum flows. • Absolute minimum and maximum liquid line velocities seldom should be less than 0.2 m/s or more than 4.5 m/s. **Hydraulic Surges (Transients or Water Hammer)** Hydraulic surge, commonly called "water hammer," is a change in fluid pressure due to an increase or decrease in the flow velocity within a piping system. The fundamental formula is: $\Delta H = \frac{a}{g}\Delta V$ where: ΔH = change in head, in metres ΔV = change in velocity from V_o (steady state), in m/s g = gravitational acceleration constant = 9.81 m/s^2 a = speed of sound in the fluid pipe system, in m/s The value of a/g usually falls between 100 and 140. Thus a sudden change in velocity of an amount ΔV = 1 m/s causes a transient pressure change ΔH = 100 to 140 metres, approximately. This is true for all cases that satisfy the equation, $T = \frac{2L}{a}$ where: T = time interval, in seconds, during the velocity change ΔV
	PLANT PIPING	**Piping**	

	SYSTEMS (Continued)	**System Hydraulics (Continued)**	L = line length, in metres Thus, any time a piping system is relatively long (300 metres or more) and the flow velocities are above 1.0 m/s, due consideration should be given to the potential for "Water hammer" under the following conditions: • If valves in the system are opened or closed rapidly, i.e., more rapidly than the time interval T above • If the system flow rate is subject to rapid acceleration or deceleration due to pump starting, stopping, or power failure As a general rule, the time required for valve closure should equal or, exceed 15 time intervals (T) in the formula above to prevent water hammer. If a piping system design fits the above criteria, or if you are uncertain as to the potential for damaging water hammer, a piping model view or plan and profile sketch of the proposed system should be prepared and sent to a hydraulic transient analysis specialist for further study. The sketch should show: • Pipeline locations, sizes, lengths, wall thicknesses and materials. • Valve sizes, locations, types, and proposed speeds of operation. • Pump locations, sizes, speeds, and characteristic curves. • Design average and maximum system flows. The pipeline profile should show: • Approximate pipeline elevations. • Pump locations, together with minimum and maximum pump suction elevations. • Reservoir locations, together with minimum and maximum water surface elevations. If further analysis is required, a computational transient analysis should be performed.
1	**PLANT PIPING**	**Piping Wall Thicknesses & Pressure Ratings** **Piping Wall**	• Wall thickness of mill-type steel and stainless steel plant piping should be determined in accordance with the ANSI/ASME B31.3 code for process piping. • Except for thin walled stainless steel piping, where corrosion naturally is less, standard wall or Schedule 40 pipe generally will be suitable for use in steel piping systems up through 300 mm nominal size. Above that size, walls thicker than 9.5 mm or thinner than 6 mm are seldom used for treatment plant steel piping. • Thickness of ductile iron pipe generally will be the pressure class above the design pressure. Of course, if the ductile iron pipe is buried, then the external loads due to soil pressure and traffic must be taken into account. • ANSI B36.10 and the ASTM material specifications state the manufacturing tolerance of thickness. For example, ASTM steel pipe specifications customarily allow a manufacturing tolerance of 12.5 percent. • Corrosion allowances should be determined on the basis of experience for the type of fluid being handled. Yearly corrosion rates for a given pipe material may be found in the

	SYSTEMS (Continued)	**Thicknesses & Pressure Ratings (Continued)**	*Chemical Engineering Handbook*. Generally speaking, the corrosion allowance should not be less than 1.5 mm, and more often 3 mm is used. • In addition to the Design Codes and Standards listed above for the more common piping materials, proprietary design information is usually available upon request from the manufacturers of reinforced concrete and concrete cylinder pipe, polyvinyl chloride (PVC) pipe, high density polyethylene (HDPE) pipe, and fiberglass reinforced plastic (FRP) pipe.
1	**PLANT PIPING**	**Piping System Thermal Expansion and Flexibility** **Piping**	• Unlike pipe support systems, thermal expansion provisions cannot be left to the contractor for design when they are required. Once piping is laid out, the potential expansion movement must be calculated with consideration for the pipe length, material, and the range of temperature the piping may experience. • Where the expansion is within the allowable flexure and allowable pipe wall stress for the particular pipe material and where the support system does not hinder movement, then it is best to avoid the use of expansion joints, compensators, or flexible metal hose. • All piping systems must be reviewed for thermal expansion needs. Details regarding piping expansion and flexibility are to be developed during detailed design. • The allowable flexure and expansion stress range for piping systems must be determined in accordance with the requirements of the ANSI codes listed under the Piping Design Codes and Standards above. This calculation is independent of that used to determine pipe wall thickness. However, pipe wall thickness must be determined before the stress range caused by temperature expansion of the piping can be calculated. The thermal expansion is then kept within allowable limits by use of selective piping configurations that allow for expansion, or by the use of expansion joints. • In the case of plastic piping, the manufacturers generally provide formulas for calculating the geometry of expansion offsets and loops. • Where expansion provisions are part of the piping system design, the pipe support system must be designed and detailed as necessary to include pipe guides adjacent to expansion joints, pipe anchors to direct the expansion and rolling or sliding supports to carry moving piping. • Anchor loads for piping with expansion joints must be calculated to determine if special structural design is required for the structural attachment or if a special design is required for the anchor attachment to the pipe. The anchor load is caused by the system pressure acting on the expansion joint inside cross-sectional area plus the joint resistance to compression. • Expansion joints should never be applied using more than half of their rated deflections at normal operating temperatures. • The contractor should also be directed as to the initial installation condition of expansion joints; whether they are to

	SYSTEMS (Continued)	**System Thermal Expansion and Flexibility (Continued)**	be compressed, extended, or left at their neutral length, or with length set according to ambient temperature at the time of piping length closure. • Where anchor loads would be excessive with expansion joints, flexible metal hose may be considered in a piping offset to eliminate the thrust load due to pressure and joint compression. The flexible metal hose specified has a braided thrust restraining jacket. • As the piping moves to offset the hose ends, the only anchor load is the pipe weight friction component at the hangers and supports. • In long, straight piping runs, thermal expansion may be a problem even though the fluid carried is at moderate temperature, depending upon the difference between installation and operating temperatures. • Even for smaller temperature differences, thermal expansion can be a problem when a pipeline is relatively long (50 to 100 m).
1		**Piping System Supports**	• All piping larger than 600 mm must be shown with specific details indicated, and all supports located on the drawings. • Supports must be provided at changes in direction and adjacent to or under flanges of heavy valve bodies and flowmeter bodies. • Future maintenance operations, requiring removal and replacement of piping and valves, need to be considered for selection of appropriate supports and their locations. • The pipe support specifications require the contractor to design all pipe supports and seismic bracing for piping through 600 mm in diameter. • Locations for rigid pipe anchorage for thermal expansion control, however, must be shown regardless of diameter. • Contract drawings should illustrate typical support types in appropriate views, for the purpose of indicating a general approach to piping support; for example, a drawing may show piping being supported from the floor rather than from the overhead structure. • Pipe support materials and component manufacturer model numbers will not be shown on standard details, but will be referenced to the specifications. • The designer should refer to Specification Section 15060, PIPING SUPPORTS, for the types of systems available already specified. • Standard details also are available for many common support and hanger arrangements. The contractor will be able to obtain support and hanger shop drawings from pipe support fabricators and subcontractors. These fabricators and subcontractors also offer design service to provide load rated components in accordance with the specifications. • Piping 750 mm and larger and all piping where the designer requires specific supports at specific locations shall include the detail design of supports and hangers. • Channel-type support systems such as Anvil International Powerstrut and Unistrut are good systems for runs of several different pipes through galleries and chemical tank farms.

	PLANT PIPING SYSTEMS (Continued)	**Piping System Supports (Continued)**	Corrosion resistant alloy and FRP versions are also available. • There are limitations to the use of these channel systems though. The load-carrying capacity of long spans of channel may not be adequate where several large ductile iron services are run. Channel moments and stresses must be checked for the worst case to be sure you are not asking a contractor to design a system for which members are not available to meet all conditions. Channel framing supports offer little resistance in the pipe axis direction and therefore are not to be used for anchors except for only the smaller piping and lower pressures. Again, always calculate the loads to determine the limiting size and pressure. • Another limitation of the channel framing systems is that many of the common catalog pipe support items such as pipe rolls and pipe guides require some adaptation to the channels and these should be detailed. • Duct support design is covered separately by the Building Mechanical Design Basis Memorandum.
1		**Piping System Hydraulic Thrust Restraint**	• Hydraulic thrust is produced wherever a flexible joint occurs, such as at flanged coupling adapters, flexible sleeve couplings (Dresser type), rubber-ring sealed buried pipe joints, and at expansion joints. • The thrust is the system pressure acting on the area of the outside diameter of the pipe, or in the case of the expansion joint, the cross-section area of the inside of the bellows arch. • Elastomer bellow expansion joints are provided with extension-limiting rods to protect the bellows from over extension, but these are normally unloaded if the joint is functioning properly. • Dynamic thrust of fluid flow through a bend is usually of much lower magnitude and is a function of the fluid-specific weight and velocity. • Hydraulic thrust must be restrained to keep pipe joints together when pressurized. • Thrust tie and welded lug assemblies for steel pipe are covered by a standard detail. • Ductile iron pipe 300 mm and smaller can be restrained at flanged coupling adapters with anchor studs provided in the coupling by the manufacturer. The anchor studs engage holes drilled through the end of the pipe. • Flanged dismantling joints are also available for restrained final closure pieces in ductile iron and steel piping systems beyond the size range covered by flanged coupling adapters with anchor studs. • Thrust tie rods may also be attached to piping with socket clamps. The socket clamps must engage a flange or grooved joint coupling between the clamp and the flexible joint. Socket clamps are available up to 600 mm, but pressure ratings are low in the larger sizes. • Buried pipe thrust restraint may be provided by joints individually restrained with thrust tie rod assemblies or proprietary restrained joints for ductile iron pipe.

	PLANT PIPING SYSTEMS (Continued)	**Piping System Hydraulic Thrust Restraint (Continued)**	• Buried pipe thrust restraint may also be carried by concrete thrust blocks where adequate soil-bearing pressure is available. • Additional information and guidance on thrust restraint for buried piping is covered by the Civil Discipline Design Basis Memorandum.
1		**Piping System Accessories & Specialties**	**General** • Various piping components that are occasionally required for certain systems could be sight flow indicators (rotameters), safety heads, rupture discs, hose and couplings, strainers, and swivel joints. These types of items are to be specified within Specification Section 15205, PROCESS PIPING SPECIALTIES. **Pipe Coatings and Linings** • Corrosion protection by coating and lining is to be covered by the detailed piping specifications. For coatings and linings requirement for specific services see Sections 19, and 22 of the PDR. **Thermal Insulation** • The common insulations to be considered for application to water treatment works piping are fiberglass, calcium silicate, and foamed glass. • Fiberglass is by far the most commonly used and although rated to 450°C, it is generally not applied above 230°C. • Calcium silicate is generally not applied below 230°C or above 530°C. • Foamed glass insulation can be rated to 650°C, but would be recommended in water treatment works as an underground insulation, subject to freezing and thawing. • Foamed glass (Pittsburgh Corning Foamglas), has low water permeability, low water absorption, low coefficient of thermal expansion, and a high compressive strength. • Insulation thickness should be selected for economy, and this can be done for a given insulation type of evaluating the present worth of energy loss over a period of time compared to the present worth of the insulation system over the same period of time. • Insulation of hot piping for the safe surface temperature to which people may come in contact shall be selected to provide not more than 49°C surface temperature. • The various manufacturers should be consulted for recommended vapor barriers, jackets, and finishes. • Buried insulated steel and copper piping should be the pre-insulated type with an outer protective conduit. These piping systems are available in many multiple pipe configurations within a single conduit. **Heat Tracing** • Heat tracing of piping will be required for freeze protection or to maintain the temperature of certain fluids that would become too viscous or may crystallize upon loss of heat. Examples of the later would be heavy fuel oil and saturated

	PLANT PIPING SYSTEMS (Continued)	**Piping System Accessories & Specialties (Continued)**	solution of sodium hydroxide (caustic), respectively. • The specification Section 16055, PIPE HEAT TRACING, includes electric heat tracing of the self-limiting cable type. The manufacturer's literature includes all of the necessary information for design. • Heat tracing is primarily electrical work and the selection of voltage and thermostats must be coordinated with the Electrical Discipline work on the project. **Freeze Protection** • Outdoor piping and tubing for water services and instrumentation are subject to the design minimum ambient temperature of -26 ºC (-15 ºF). This temperature is based on the mean low temperature minus one standard deviation from the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 2001 Fundamentals Handbook, Chapter 27. • Freezing temperature periods are long enough to be a risk to small diameter exposed piping, especially those with no flow or very low flow. • The ASHRAE Fundamentals Handbook, Chapter 24, Thermal and Moisture Control in Insulated Assemblies—Applications, describes the calculation of insulation thickness and time to freeze for varying temperature conditions and pipe sizes. • It is assumed that the maintenance temperature for the process piping is 5 ºC for all cases except sodium hydroxide (caustic) and sodium bisulphate (SBS). • Sodium hydroxide (50% concentration) requires a maintenance temperature of 12 ºC to prevent freezing. • SBS (38% concentration) requires a maintenance temperature of 6 ºC to prevent freezing. • For freeze protection at the Winnipeg WTP, minimum insulation thickness will be 25 mm with a protective aluminum jacket. Pre-formed sectional fiberglass insulation is recommended. **Pipeline Pigging** • Pigging facilities should be designed into all pipelines subject to sludge or scale accumulations. This includes, but is not limited to: ➢ DAF sludge ➢ Washwater sludge ➢ Thickened sludge transfer ➢ Sanitary • Pigs can negotiate short-radius bends, tees, laterals, and pipe reductions as small as 65 percent of the main line size. However, pigs can hang up on rectangular-ported valves. • Use only round-ported eccentric plug valves in lines to be pigged. Consult both the pig manufacturer (Girrard-confirmation required) and King County for additional design criteria.

1	**VALVES, GATES & ACTUATORS**	**General**	To provide uniformity for design and maintenance at the Winnipeg WTP, the valve coupling configurations that shall be used are as follows: **Valve Coupling Configurations** **Type** / **Size** / **Configuration** Gate: ≤ 50 mm — Screwed; ≥ 65 mm — Flanged Butterfly: 75 to 500 mm — Flanged and Wafer Pattern; ≥ 600 mm — Flanged Plug, Globe, and Ball: ≤ 50 mm — Screwed; ≥ 65 mm — Flanged Check: ≤ 50 mm — Screwed; 65 to 500 mm — Flanged and Wafer Pattern; ≥ 600 mm — Flanged Diaphragm: ≤ 50 mm — Solvent socked weld solid plastic body and flanged, lined metal body; ≥ 65 mm — Flanged Pinch: ≥ 65 mm — Flanged • Spring assisted closure may be recommended for larger swing check valves, depending on system static head and configuration. A transient analysis specialist can assist in making this determination. • Where flanged ends are specified, valves with rigid grooved ends are also acceptable for general water and air services, provided they meet valve specifications in all other respects, and are supported to prevent rotation in the grooves.
1		**Valve Types**	• Valve types to be used for various process services are presented in the tables below. The recommended valve type shall be used unless the specific application requires another type for throttling applications. • Knife gate valves inherently exhibit leakage problems at the sealing surfaces of their gate slides. This is particularly true for very large gates. The use of knife gates should be avoided where the valves must be operated frequently. They are satisfactory, however, for isolation valves operated only occasionally. Resilient seated designs are preferred. • If large knife gate valves are required, larger than 900 mm, bonneted knife gates having a better seal design are available at a cost premium. It is better to use a sluice gate or butterfly valve larger than 900 mm if location or fluid properties permit.

<table>
<tr>
<td></td>
<td>VALVES, GATES & ACTUATORS (Continued)</td>
<td>Valve Types (Continued)</td>
<td>
Valves for Process Water and Sludge Services
<table>
<tr><th>Size</th><th>Isolation</th><th>Throttling</th></tr>
<tr><td colspan="3">Water Streams with No Stringy Materials</td></tr>
<tr><td>≤ 75 mm</td><td>Gate</td><td>Eccentric plug</td></tr>
<tr><td>≥ 100 mm</td><td>Butterfly</td><td>Butterfly and MWD multi jet sleeve</td></tr>
<tr><td colspan="3">Sludges and Streams with Stringy Materials</td></tr>
<tr><td>≤ 300 mm</td><td>Eccentric plug</td><td>Eccentric plug</td></tr>
<tr><td>≥ 350 mm</td><td>Knife gate</td><td>Diamond port knife gate or slide gate</td></tr>
</table>
Valves for Clean Water and Air Services
<table>
<tr><th>Size</th><th>Isolation</th><th>Throttling</th></tr>
<tr><td>≤ 50 mm</td><td>Ball</td><td>Globe</td></tr>
<tr><td>65 and 75 mm</td><td>Gate</td><td>Globe</td></tr>
<tr><td>≥ 100 mm</td><td>Butterfly</td><td>Butterfly</td></tr>
</table>
Valves for Fuel Oils and Gaseous Fuels
<table>
<tr><th>Size</th><th>Isolation</th><th>Throttling</th></tr>
<tr><td>≤ 50 mm</td><td>Lubricated plug</td><td>Globe</td></tr>
<tr><td>≥ 65 mm</td><td>Lubricated plug</td><td>Globe</td></tr>
</table>
Valves for Chemical Service
<table>
<tr><th>Size</th><th>Isolation</th><th>Throttling</th></tr>
<tr><td>≤ 50 mm</td><td>Ball and Diaphragm</td><td>Diaphragm</td></tr>
<tr><td>≥ 65 mm</td><td>Diaphragm</td><td>Diaphragm</td></tr>
</table>
Valves for Slurries (abrasive)
<table>
<tr><th>Size</th><th>Isolation</th><th>Throttling</th></tr>
<tr><td>All Sizes</td><td>Pinch</td><td>Pinch</td></tr>
</table>
</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Valve Materials of Construction</td>
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As a general rule, the materials presented in the table below shall be used for valve bodies. Specific recommendations must be developed after the process services are identified. These recommendations may differ from the general rules below.

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</table>

	VALVES, GATES & ACTUATORS (Continued)	**Valve Materials of Construction (Continued)**	**Valve Material Overview** **Size and Body Material** **Valve Type** / **≤ 50 mm** / **≥ 60 mm** Gate / Bronze / Iron Knife Gate / --- / Steel, w/316 SS wetted parts Butterfly / --- / Iron Eccentric Plug / Iron / Iron Lubricated Plug / Iron, Steel / Iron, Steel Globe / Bronze / Iron Globe Type Plug / Bronze / Iron Ball - Noncorrosive / Bronze / --- Ball - Corrosive / PVC, CPVC, or Alloy / --- Check / Bronze / Iron Diaphragm / Solid Plastic or Alloy / Plastic or elastomer-lined iron or steel Pinch / --- / Iron w/elastomer sleeve
1		**Valve Pressure Ratings**	• Screwed end bronze valves through 75 mm are available in all of the common ratings except 250 pound SWP. • Flanged cast iron valves, 50 mm and larger are available in the 125 and 250 pound SWP ratings only. • For very high pressure and temperature applications, the above valves are available in cast steel and alloys in ANSI B16.5 pressure classes of 600, 900, 1,500, and 2,000 pound. • There is some compatibility of mating cast iron and ductile iron flanges to steel flanges. 125 pound and 150 pound flanges may be mated although the 150 pound flange has a raised face. Where possible, the joint should be bolted as specified in the piping specification with bolts of specific strength to afford some protection against breaking the cast iron flange. 250 pound and 300 pound flanges may also be mated. Both of these flanges have a raised face and the raised face diameter differs slightly. • Under the AWWA standards, valve manufacturers offer valves generally corresponding to the ANSI B16.1 standard for cast iron pipe flanges. Although most manufacturers offer valves in all sizes included in the ANSI standard, the AWWA standards do not include the 350 mm and 450 mm sizes. • The important AWWA standards and the corresponding pressure ratings are presented in the table below:

<table>
<tr>
<td></td>
<td>VALVES, GATES & ACTUATORS (Continued)</td>
<td>Valve Pressure Ratings (Continued)</td>
<td>
AWWA Standards for Valves
<table>
<tr><th>AWWA Standard</th><th>Rating and Size</th><th>ANSI B16.1 Flange</th></tr>
<tr><td>C500 Gate Valves</td><td>200 psi/≤ 300 mm
150 psi/≥ 350 mm</td><td>125 pound flat-face</td></tr>
<tr><td>C504 Rubber-Seated Butterfly Valves</td><td>150 psi/≤ 500 mm
25, 75, 150 psi/≥ 600 mm</td><td>125 pound flat-face</td></tr>
<tr><td>C507 Ball Valves</td><td>150 psi/150 thru 1200 mm
250 and 300 psi/150 thru 1200 mm</td><td>125 pound flat-face
250 pound raised-face</td></tr>
</table>
Many of the manufacturers of AWWA valves also offer 250 and 300 psi rated versions of the AWWA gate valves and butterfly valves although the higher pressure ratings are not included in the AWWA standards for these valves.
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<tr>
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<td></td>
<td>Manual Valve Operators</td>
<td>
In general, the following types of manual valve operators shall be specified. Final selection will depend upon the differential pressure across the valve when closed, or the operating line pressure.
Valve Operators
<table>
<tr><th>Valve Type</th><th>Size</th><th>Operator</th></tr>
<tr><td>Gate</td><td>≤ 350 mm
≥ 400 mm</td><td>Geared Handwheel</td></tr>
<tr><td>Knife Gate</td><td>≤ 500 mm
≥ 600 mm</td><td>Geared Handwheel</td></tr>
<tr><td>Butterfly</td><td>≤ 200 mm
≥ 250 mm</td><td>Locking lever
Geared handwheel w/horizontal disc shaft</td></tr>
<tr><td>Eccentric Plug</td><td>≤ 150 mm
≥ 200 mm</td><td>Wrench lever
Geared handwheel</td></tr>
<tr><td>Lubricated Plug</td><td>≤ 150 mm
≥ 200 mm</td><td>Wrench lever
Geared handwheel</td></tr>
<tr><td>Globe</td><td>≤ 150 mm
≥ 200 mm</td><td>Handwheel
Geared handwheel</td></tr>
<tr><td>Ball</td><td>All sizes specified</td><td>Lever</td></tr>
<tr><td>Diaphragm</td><td>All sizes specified</td><td>Handwheel</td></tr>
<tr><td>Pinch</td><td>All sizes specified</td><td>Handwheel</td></tr>
</table>
Valves shall be installed with operating mechanisms vertically upward or horizontal, never vertically downward.
Installation at an inclined angle above the horizontal is also permissible, but for appearance should be limited to situations where interference must be avoided.
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</table>

	VALVES, GATES & ACTUATORS (Continued)	**Manual Valve Operators (Continued)**	• Valves installed horizontally with stem, centerlines more than 2.0 m above the operating floor or grade shall be furnished with chain wheel operators. Chains shall extend to within 1.2`m of the floor or grade. Nested valves with chains shall have staggered operators. • Within certain size ranges and pressure ratings, gate valves can be obtained with inside-screw non-rising stem, inside-screw rising stem, or outside screw rising stem. • Globe valves are available with either an inside or outside-screw rising stem. • The valve stem packing of outside-screw and yoke (OS&Y) valves is between the thread and the process fluid. Since the threads do not contact the fluid, these valves are recommended for corrosive and high temperature applications. • The position of the stem gives an indication of the amount of valve opening, but adequate headroom must be provided for the rise of the stem when the valve is opened. The outside screw also permits easy lubrication of the thread. However, care must be taken to protect the exposed threads from damage. • The stem thread of inside-screw valves is within the valve and thus exposed to the process fluid. The rising-stem gate and globe valves of this type give an indication of plug or disc position, but adequate headroom must be available the rise of the stem. • The non-rising stem gate valve should be used where headroom is limited. They should be used for buried service and in environments where exterior threads would be subject to corrosion or damage. • Buried valves shall be equipped with square-head operating nuts and tee-wrenches in place of handwheels. Some buried valves with enclosed, geared operators are available with a ground level position indicator and this should be specified where desired.
1		**Automated & Control Valves**	**General** • In most cases the need for automated (power-actuated) valves shall be determined by process requirements. In addition to the process requirements, power actuators shall be provided for the following applications: ➢ Where valve operation is required at least once per shift ➢ Where quick valve operation may be required because of an emergency condition ➢ For very large valves where manual operation is cumbersome or a H&S risk ➢ Where slow valve operation is required to control water hammer • All power-actuated valves shall be provided with manual over-ride operators (i.e. hand wheels, levers etc). Refer to Manual Valve Operators above, for additional guidance. **Solenoid Valves** • Solenoid valves larger than a 40 mm size are not to be used for OPEN/CLOSE process control.

	VALVES, GATES & ACTUATORS (Continued)	**Automated & Control Valves (Continued)**	• In detailing solenoid valves on drawings, show a ball valve and union upstream of the solenoid valve, so that the line may be isolated for solenoid valve replacement. **Valve Bypasses and Isolation** • The choice of whether to provide a bypass around a control valve is governed by the importance of the process or stream being controlled. • If the stream can be shut down long enough to replace the control valve without upsetting a critical process, no bypass is required. • If the process is critical and can't be controlled by manual throttling, a redundant control valve must be provided. • Regardless of whether or not a bypass is provided, manually operated isolation valves will usually be required on either one side or both sides of the control valve to facilitate its removal and replacement.
		Flow Characteristics of Control Valves	**General** • The flow characteristic of a control valve is the relationship between the flow rate through the valve and the valve travel as the travel is varied from 0 to 100 percent. • "Inherent flow characteristic" refers to the characteristic observed with a constant pressure drop across the valve. • "Installed flow characteristic" means the one obtained in service, where the pressure drop varies with flow and other changes in the system. • The purpose of characterizing control valves is to provide control loop stability over the expected range of system operating conditions. • To establish the flow characteristic needed to best control a given process requires a dynamic analysis of the control loop. However, analyses of the more common processes have been performed, so some useful guidelines for the selection of the proper flow characteristic are already established from experience. Typical inherent flow characteristic curves are also available in valve manufacturer's literature. **Quick-Opening** • The quick-opening characteristic is one normally limited to globe-style valve bodies. • A valve with a quick-opening flow characteristic provides a maximum change in flow rate at low travels, when the valve is near the closed position. The curve is basically linear through the first 40 percent of valve plug travel, and then flattens out noticeably to indicate little increase in flow rate as travel approaches the wide open position. • Control valves with quick-opening flow characteristics are to be used for OPEN/CLOSE applications only, where a significant flow rate must be established quickly as the valve begins to open. Consequently, they are often used in relief valve applications. • Quick-opening valves can also be selected for many of the same applications for which linear flow characteristics are recommended, since the quick-opening characteristic is linear up to about 70 percent of maximum flow rate. Linearity

	VALVES, GATES & ACTUATORS (Continued)	**Flow Characteristics of Control Valves (Continued)**	decreases sharply after the flow area generated by valve plug travel equals the flow area of the port. For a typical quick-opening valve, this occurs when valve plug travel equals one-fourth of the seat diameter. **Linear** • The linear flow characteristic curve shows that the flow rate is directly proportional to the valve travel, throughout the travel range. For instance, at 50 percent of rated travel, flow rate is 50 percent of maximum flow; at 80 percent of rated travel, flow rate is 80 percent of maximum; etc. • Change in flow rate is constant with respect to valve travel. This proportional relationship produces a characteristic with a constant slope so that with constant pressure drop, the valve gain will be the same at all flows. (Valve gain is the ratio of an incremental change in flow rate to an incremental change in valve plug, disc, or ball position. Gain is a function of valve size and configuration, system operating conditions, and valve flow characteristic.) • Valves with a linear characteristic are commonly specified for liquid level control and for certain flow control applications requiring constant gain. The linear flow characteristic shall be applied where the control valve pressure drop is 60 percent or more of the total pressure drop at all flowing conditions. **Equal Percentage** • In the equal percentage flow characteristic, equal increments of valve travel produce equal percentage changes in the flow. The change in flow rate is always proportional to the flow rate just before the change in valve plug, disc, or ball position is made. • When the valve plug, disc, or ball is near its seat and the flow is small, the change in flow rate will be small; with a large flow rate, the change in flow rate will be large. • Valves with an equal percentage flow characteristic are generally used on pressure control applications. The equal percentage flow characteristic shall be used if the major portion of the system pressure drop is not available across the valve. What constitutes a major portion of the system varies with each application. • Valves with an equal percentage characteristic should also be considered where highly varying pressure drop conditions can be expected. **Modified Parabolic** • The modified parabolic characteristic is not in widespread use today. Although seldom designed into a valve intentionally, it is, nonetheless, one that is inherent in many valve shapes. • Its use is dictated more often by the type of valve that must be used in a given service (e.g., with slurries or stringy solid-laden fluids) than by a specific control application. • At small valve openings the valve characteristic is somewhat similar to that of equal percentage valves. After about the first 40 percent of valve travel, the characteristic approaches a linear characteristic. **Selection of Flow Characteristic**

VALVES, GATES & ACTUATORS (Continued)

Flow Characteristics of Control Valves (Continued)

- Experience shows that when in doubt, it is better to pick an equal percentage characteristic. Using a linear characteristic where an equal percentage characteristic would be better often leads to an unstable system. However, the reverse situation seldom causes instability.
- It should be noted that where a linear characteristic is recommended, a quick-opening valve plug could also be used; although the controller will have to operate on a wider proportional band setting, the same degree of control accuracy may be expected.
- If a good dynamic analysis of the system is available, or if there is sufficient time to make one, the valve flow characteristic that is best suited in a particular control loop can be selected without reliance on the guidelines listed above. However, without a dynamic analysis, trouble can usually be avoided by following the suggestions above, although optimum control may not be reached.
- The Fisher Controls *Control Valve Handbook* lists some guidelines that will help in the selection of the proper flow characteristic. Remember, however, that there will be occasional exceptions to most of these "rules of thumb," and that a positive recommendation is possible only by means of a complete dynamic analysis.
- The table below shows characteristics of valves commonly used in water treatment and solids handling service.

Valve Characteristics of Common Valve Types

Valve Type	Typical Model or Manufacturer	Characteristic
Butterfly	Fisher Fishtail	Equal Percentage
Eccentric Plug	Homestead Ballcentric Dezurik Fig. 100	Modified Linear
Vee-Ball	Fisher Design "U"	Equal Percentage
V-Port	Dezurlik	Modified Linear to Linear
Ball	Neles-Jamesbury McCanna	Equal Percentage
Saunders Diaphragm	Grinnell McCanna	Modified Parabolic
Globe Body	Fisher Masoneilan Neles-Jamesbury	Quick Opening Linear Equal Percentage
Pinch	Red Valve Co. RKL Controls	Modified Parabolic

- The tables below provide generally recommended characteristics of valve characteristics for typical applications.

Flow Control Processes

		Best Inherent Characteristics	
Flow Measurement Signal to	**Location of Control Valve in**	**Wide Range of Flow Set**	**Small Range of Flow but Large ΔP Change at**

VALVES, GATES & ACTUATORS (Continued)

Flow Characteristics of Control Valves (Continued)

Controller	Relation to Measuring Element	Point	Valve with Increasing Load
Proportional to Flow	In Series	Linear	Equal Percentage
	In Bypass[1]	Linear	Equal Percentage
Proportional to Flow Squared	In Series	Linear	Equal Percentage
	In Bypass[1]	Equal Percentage	Equal Percentage

[1]When control valve closes, flow rate increases in measuring element

Pressure Control Systems

Application	Best Inherent Characteristic
Liquid Process	Equal Percentage
Gas Process. Small Volume, Less Then 3 metres of Pipe Between Control Valve and Load Valve	Equal Percentage
Gas Process. Large Volume /Process has a receiver, distribution system or transmission line exceeding 30 metres of nominal pipe volume decreasing ΔP with increasing Load, ΔP at Maximum Load > 20°6 of Minimum Load ΔP	Linear
Gas Process. Large Volume. Decreasing ΔP with Increasing Load. ΔP at Maximum Load < 20% of Minimum Load ΔP	Equal Percentage

Liquid Level Systems

Control Valve Pressure Drop	Best Inherent Characteristic
Constant ΔP	Linear

	VALVES, GATES & ACTUATORS (Continued)	**Flow Characteristics of Control Valves (Continued)**	Decreasing ΔP with Increasing Load. ΔP at Linear Maximum Load > 20% of Minimum Load ΔP Decreasing ΔP with Increasing Load. ΔP at Equal Percentage Maximum Load < 20% of Minimum Load ΔP Decreasing ΔP with Increasing Load. ΔP at Linear Maximum Load < 200% of Minimum Load ΔP Decreasing ΔP with Increasing Load. ΔP at Quick Opening Maximum Load > 200% of Minimum Load ΔP
	VALVES, GATES & ACTUATORS (Continued)	**Control Valve Sizing** **Control Valve Sizing (Continued)**	**General** • Once the valve configuration and flow characteristic are selected, the control valve can be sized for the capacity best suited to control the process. • The main challenge in sizing control valves is turndown, i.e., the ratio of maximum to minimum flow. As a "rule of thumb," a turndown ratio of 5:1 should not be exceeded, although in steam applications turndown ratios of 10:1 are sometimes required. • The C_v method of sizing shall be used. Valve sizing equations such as those given in ANSI/ISA Standard S75.01.01 shall be used. These equations include correction factors for non-turbulent flow conditions, pipe reducer effects, compressibility factor for gases, and specific heat ratio compensation. • Valve position should be maintained so that the valve operates in the more linear portion of the flow coefficient (C_v) curve (between approximately 20 to 70 percent) for optimum control. **Pressure Drop (ΔP)** • The required valve size is calculated after determining the maximum and minimum flow rates of the system and the pressure drops (ΔP) at each flow rate, including the average. The following guidelines shall be followed for allocating ΔP and sizing valves for various applications: • Valves shall be sized to pass the maximum flow at minimum ΔP with the valve operating at not more than 80 percent of maximum capacity. • In a pumped system, the ΔP across the control valve at maximum flow should be: ➢ Forty percent of the system total frictional losses (including the control valve) when the static head exceeds 75% of the total dynamic head (TDH) ➢ Thirty percent of the system total frictional losses (including the control valve) when the static head is between 50 and 70% of TDH ➢ Twenty percent of the system total frictional losses (including the control valve) when the static head is less than 50% of TDH ➢ In all cases, the valve: closure must be checked at the maximum throttling (minimum opening) position. If it is not at least 10 percent open, a smaller valve or a valve

			with a different characteristic must be used. The preferred minimum opening is 15%. • In a system where static pressure moves liquid from one pressure vessel to another, the pressure drop allocated to the control valve should be 10% of the static pressure or 40% of the system total frictional losses (including control valve) at maximum flow, whichever is greater. As before, the minimum valve opening must be at least 15%. • The above ΔP allocations may be reduced with proper care and attention for systems where the dynamic losses are well defined and load changes are minimal. • Control valve ΔP cannot be determined independently of other system components. Control valve ΔP must be calculated taking into account pump curves, line losses, elevation differences, and static heads, at maximum flow, average flow, and minimum flow conditions. **Flow Sizing Coefficients (C_V and Cg)** • Control valve capacities are listed in terms of sizing coefficients in all manufacturer's literature. They are expressed in USgpm at 1 psi differential pressure liquids, or in standard cubic feet per hour at 1 psi differential pressure for gases. Metric equivalents may be available. • The sizing coefficient is expressed as C_v for liquids and Cg for gases. Some manufacturers do not use a specific coefficient for gases. Instead, they employ a conversion method to handle compressible fluids using the liquid flow sizing coefficient, C_v. • Using the manufacturer's published techniques, it takes only a few minutes to select a valve with the proper capacity from a sizing chart and check for flashing or cavitating conditions. • Best control will come with a valve that is neither oversized nor undersized, and most manufacturers supply a logical progression of capacities in their ranges to aid in selecting optimal valve sizes. • Restricted trim is also available for applications where future demands for capacities might be greater than today's, or where the designer wishes to avoid a situation where a 200 mm line was sized down to handle a 50 mm valve.
1	**VALVES, GATES & ACTUATORS (Continued)**	**Control Valve Cavitation Control** **Control Valve Cavitation Control (Continued)**	• Cavitation occurs in a fluid when the fluid forms vapor bubbles at low pressure; then, upon an increase in pressure the vapor bubbles collapse and release acoustic energy, which can damage adjacent materials. • The best method of cavitation control is to prevent the low pressure condition that forms the vapor bubbles. This can often be accomplished by installing the control valve where static head is maximized or by providing adequate downstream head with system friction loss. • Many control valves are characterized with regard to their incipient cavitation. The cavitation index is the absolute downstream pressure divided by the pressure drop across the valve at incipient cavitation. • Many control valve manufacturers offer special valve trim and materials to resist cavitation damage. • Some situations may be best handled with control valves in

			series.
1		**Valve Torque, Thrust and Actuators**	**General** Actuators are either a sliding stem or rotary type. Within these two general categories there are five basic actuator types. A description of each type and its application follows. **Electric Motors** • Electric actuators usually consist of motors with gear trains to provide a wide range of torque outputs. A prime advantage is their use in remote installations where no instrument air source is available. • Electric actuators are normally economical only in relatively small thrust (600 to 1,000 pound, or 2.7 to 4.5 kN) ranges. • Large units with high thrust generally operate slowly and weigh considerably more than their pneumatic counterparts. • At this time, there are no electric actuators economically available with fail-position action other than lock-in-last-position. • Throttling-control designs are somewhat limited in capability, however designs are improving. In continuous, closed-loop throttling applications, where very frequent changes are made to control valve position, the electric actuator may be unsatisfactory due to limited duty cycles and slow response. **Spring and Diaphragm** • The pneumatic spring-and-diaphragm actuator offers high reliability at low cost. It is also fast-acting. • The principle advantage of the spring-and-diaphragm actuator is its fail-safe action upon loss of actuation pressure. As air is loaded on the diaphragm casing, the diaphragm moves the valve and compresses the spring. Energy stored in the spring moves the valve back to its original position as air is removed from the casing. • Where the diaphragm is actuated directly by an instrument output signal, signal pressure loss to either the instrument or the actuator will cause the spring to move the valve to its initial (fail-safe) position. • Spring and diaphragm actuators are available for either fail-open or fail-closed action. • Diaphragm actuators normally operate using air signal ranges of 3 to 15 psig or 6 to 30 psig. Because of this, they can often provide throttling control (continuous, proportional pressure control) while operating directly from instrument air-pressure signals. • However, without positioners valves may be sensitive to line pressure. • Since diaphragm actuators have few moving parts, they are extremely reliable and easy to maintain. • The primary drawback of spring-and-diaphragm actuators is their relatively limited thrust capability. Much of the force created by the diaphragm is absorbed by the spring and does not result in thrust output. The spring-and diaphragm actuator ceases to be cost-effective for thrust requirements in excess of about 2,000 pounds (9 kN) or torque requirement over 5,000
	VALVES, GATES & ACTUATORS (Continued)	**Valve Torque, Thrust and Actuators (Continued)**	

	VALVES, GATES & ACTUATORS (Continued)	**Valve Torque, Thrust and Actuators (Continued)**	inch-pounds (565 N.m). • Therefore, as a rule of thumb, spring-and-diaphragm actuators may be considered to be limited to valves 200 mm and smaller. However, they are an excellent application in this size range. **Pneumatic Piston** • Pneumatic piston actuators are an economical choice when thrust and torque requirements exceed the capability of diaphragm actuators. • Piston actuators normally work with supply pressures from 60 to 150 psig. • They are also an excellent choice when compact, high-thrust actuators are required. • They can also be used very effectively where varying service conditions require a wide range of output forces, and, therefore, a fast-acting unit. • Piston actuators used for throttling control require a double-acting positioner that will simultaneously load and unload opposite sides of the piston. The differential pressure created across the piston causes travel toward the lower pressure side. The positioner senses this piston motion and, when the required position is reached, the positioner equalizes the pressure on both sides of the piston, preventing further piston motion. • Positioners are required in throttling applications to isolate valve position from line pressure. • The main disadvantages of piston actuators are the high air-supply pressures required, the need for positioners during throttling service, and the lack of built-in fail-safe systems. • The basic failure mode of a pneumatic piston is the fail-last position. The options for piston actuators include spring return, but the addition of springs limits the construction to much the same force outputs as the diaphragm actuator. The only alternatives to springs are pneumatic trip systems, which move the piston actuator to its fail-safe position. These consist of an air volume tank and trip valve which, though quite reliable, add to the overall system complexity, maintenance, and cost. • Pneumatic piston actuators should be considered where high valve forces, torques, or thrusts exist, where long valve strokes are required, or where valves are large. If a valve is 200 mm or larger, it may require a pneumatic piston. **Hydraulic** • Hydraulic actuators are powered by an external pumping unit. High-pressure hydraulic fluid, sometimes up to 3,000 psig, can be supplied from a central hydraulic pumping unit. • Actuator control is accomplished through a servo-amplifier and a system of hydraulic valves. This system can provide the ultimate in actuator performance, i.e., exceptional stiffness, fast stroking speeds, very high thrust (sometimes up to 50,000 pounds, or 220 kN). However, the price tag for this performance is quite high. • Gas- or spring-charged hydraulic accumulators are also

			available that have the advantage of releasing stored energy in the even of power failure. **Recommendations** • In summary, the choice of an actuator depends upon the application requirements. • Sometimes the selection is made automatically, depending upon the type of control signal, the power source available, the torque or thrust required, the manual operator requirements, the need for a specific fail-safe mode, or client preference. • The relative values of actuator simplicity, maintenance, and economy must be considered. • If a spring-and-diaphragm actuator suits the application, it should be considered first because of its simplicity, reliability, and economy. • If it is not possible to use a diaphragm actuator, the next best choice may be a pneumatic piston actuator. The piston offers the desirable combination of high thrust and relatively low initial cost. Further, it is simple and easy to maintain, which is characteristic of pneumatic actuators. • Because of their cost and complexity, electric and hydraulic actuators should be considered only when compressed air isn't readily available, or where extremes of performance are required (as discussed under these units above). • Actuators shall be factory mounted and tested before coming to site. The matching of actuator size to the valve body is best left to the control valve manufacturer. • Although actuator sizing is not difficult, the great variety of actuator designs available complicates the task. Further, the access to manufacturer expertise through suppliers makes it unnecessary for process designers to acquire detailed knowledge of actuator sizing procedures.
1	**VALVES, GATES & ACTUATORS (Continued)**	**Control Valve Accessories & Hydraulic Power Units** **Control Valve Accessories & Hydraulic Power Units (Continued)**	**Position Indicators** • Position indication shall be provided locally on all control valves by mechanical attachment or linkage to either the valve stem or valve actuator. **Positioners and Boosters** • In many control systems, a properly sized spring-and-diaphragm actuator will do an excellent job without the use of either a positioner or a booster. In other systems, a booster (pneumatic amplifier) or positioner is mandatory. A booster amplifies an instrument signal pressure or volume. A positioner isolates valve position from the influences of line pressure or flow. Pneumatic valve positioners transduce an instrument air signal to a valve position; the air signal does not control the actuator directly. • There are three principal reasons for selecting a positioner or a booster: 1) to obtain split operating ranges for two control valves, 2) to obtain a loading pressure greater than the maximum instrument signal, and 3) to obtain a finer degree of control. Examples might include rapid adjustment of a valve plug to recover quickly from process disturbances, or minimization of valve overshoot during actuation. Some

			positioners include standard and custom characterizing cams. • Proper selection of a positioner or booster is loosely related to process dynamics, but not to valve size, valve plug unbalance, packing friction, or transmission line length. The selection of either a positioner or a booster depends mainly on whether the process is classified as "slow" or "fast." • If the system is relatively fast, such as is typical of liquid pressure control loops, some gas pressure control loops, and most flow control loops, the proper choice is a booster. If the system is relatively slow, such as is typical of liquid level, blending, temperature, and some reactor control loops, the proper choice is a positioner. Fortunately, for those in-between cases when it is difficult to determine if a system is fast or slow, the choice has little effect on performance. **Solenoid Pilot Valves** • Where solenoid pilot valves are specified as a part of the control loop, they shall be provided with the main control valve. Solenoid valves shall be line size and soft-seated, with brass bodies and 120-Vac solenoid coils. **Air Exhaust Mufflers** • Mufflers shall be provided in the exhaust port of all actuator solenoid pilot valves.
1	**VALVES, GATES & ACTUATORS (Continued)**	**Slide Gates, Sluice Gates, Weir Gates & and Stop Logs** **Slide Gates, Sluice Gates, Weir Gates & and Stop Logs (Continued)**	**General** • Slide gates will be used to isolate flow in basins and channels in the Winnipeg WTP. **Slide Gates** • Slide gates will meet AWWA C561, *Standard for Fabricated Stainless Steel Slide Gates*. • It is expected that slide gates will leak, however sound fabrication can minimize this leakage. • The slide gate operator is often mounted to the gate frame to form a self-contained unit. • Slide gates shall be used only for isolation service, not for throttling. Unlike sluice gates, the slide gate can be installed in a channel without a concrete wall for the thimble. • The slide gate guides may be embedded in a grouting blockout leaving the full channel width equal to the gate. • Because the gate runs on a bearing surface throughout the travel, slide gates should not be installed in the process where abrasive grit could accumulate and wear the gate at these surfaces. • Slide gates should not be applied in unseating head installations. • Power operators shall be provided for any of the following situations: ➢ The total gate lift is 72 inches or greater ➢ The nominal gate cross sectional area is 36 square feet or more ➢ The gate is anticipated to be operated more frequently than once a week ➢ The slide gate may require rapid response to some condition

	VALVES, GATES & ACTUATORS (Continued)	**Slide Gates, Sluice Gates, Weir Gates & and Stop Logs (Continued)**	➢ The gate requires remote operation **Sluice Gates** • Wedges: ➢ Sluice gates shall have wedges only for seating head conditions. ➢ All gates 600 mm and wider subject to unseating heads of 1.5 m or more shall be equipped with side, top, and bottom (full) wedges. • Wall Thimbles: ➢ All sluice gates shall be mounted on wall thimbles. ➢ Normally, gates shall be furnished with F-section wall thimbles. However, E-section thimbles shall be considered when unseating heads are more than 7.6 metres. ➢ Also, large gates installed in thin walls often require E-section thimbles. Consult the manufacturer in such cases. ➢ When gates are in channels, the gates shall be of the "flush bottom" design. • Frames: ➢ Frames shall be the flanged type unless frame clearances preclude their use. ➢ Flanged frames require 200 to 250 mm clearance, sides and bottom, for bolt attachment during gate installation. ➢ If clearances are a problem, flat frames require only 25 mm clearance on the sides and 40 to 50 mm clearance at the bottom for installation on the thimble. ➢ Clearance differences stated are dependent upon the specific gate manufacturer. ➢ Flanged frames shall be used for all round openings provided with wall thimbles. • Stems: ➢ See Gate Operator section below. **Gate Operators** • Operators normally shall be the rising stem type to permit visual determination of gate position. • Gates 600 mm by 600 mm or smaller, or larger gates operating with less than 1 metre of unbalanced head, may have bench stand or floor-stand hand wheel operators. • All other sluice gates shall be provided with enclosed, geared-type bench stand or floor-stand operators. Consider size, unbalanced head, speed of gate travel, and frequency of operation in making the selection. Use bench stands only if they can be installed at convenient operating heights. Non-rising stem operators are available for use where needed. • All manual, geared floor-stand gate hoists should be capable of portable electric operator attachment by replacement of the crank operator with an adapter. • Electric motors for gate operator service are normally of the totally enclosed, non-ventilated type with intermittent duty ratings depending on the running torque and time required as well as the motor rated temperature rise. • Most gate operators should be capable of a 3-stroke operation, open-close-open, at the maximum ambient temperature. In

some cases, this will require a larger motor just to obtain the thermal rating, but where the gate is in a critical service, where maximum reliability is required, the specification requirements for the critical operators must be clear on the sizing requirements.

- The maximum gate operating thrust must be calculated for proper structural design of gate hoist installations.
- Hydraulic fluid power operation of gates should generally be avoided where there is any possibility of contaminating the process water with a spill or leak of hydraulic fluid.
- Cylinder operators utilizing water power have been used in water treatment works where the operator is continually submerged.
- The slide gate specifications and the manufacturer's literature should be reviewed for limitations of size, operating leads, and physical installation.
- The table below presents a general schedule for fabricated slide gates to be used at the Winnipeg WTP.

Winnipeg WTP Fabricated Slide Gate Schedule

Size	Number	Location	Use
	1	Main WTP Building – DAF Effluent Channel	Isolation of DAF treatment trains
	2	Main WTP Building – Ozone Contactors Inlets	Isolation of Ozone treatment trains
	4	Main WTP Building – Ozone Contactors Outlets	Isolation of Ozone treatment trains
	1	Main WTP Building – Filter Influent Channel	Isolation of Filter treatment trains
	8	Main WTP Building – Filter Influent/WW Gullets	Isolation of Individual Filter Units (influent)
	8	Main WTP Building – Filter Influent/WW Gullets	Isolation of Individual Filter Units (Washwater)
	4	Washwater Recovery Basins	Isolation of Individual Recovery Basins
		Freeze-thaw Lagoons	Removal of decant water

* Indicates a weir gate

1	**HOISTING AND CONVEYING EQUIPMENT**	**General**	• This section covers criteria for two varieties of hoisting equipment: bridge cranes and monorail cranes. • Hoists themselves will also be discussed, as well as electrification, controls, and variable-speed drive systems. • A list of the cranes and hoists identified for the Winnipeg WTP are described in the table below:

Crane and Hoist Schedule

Description	Capacity	No.	Location	Use
Bridge Crane/Traveling Monorail	<> tonnes	1	Main WTP Building – Maintenance Workshop	Loading and unloading of equipment
Travelling Monorail and Hoist	<> tonnes	2	Main WTP Building – Residuals Area	Maintenance of gates, valves, pumps, and thickener drives
Monorail and Hoist	<> tonnes	1	Main WTP Building – Raw Water Pumping Station	Maintenance of valves and pumps
Traveling Monorail and Hoist	<> tonnes	<>	Main WTP Building – Rapid Mix Area	Maintenance of valves and mixing pumps
Traveling Monorail and Hoist	<> tonnes	<>	Main WTP Building – Floc/DAF Operating Floor	Maintenance of mechanical mixers
Traveling Monorail and Hoist	<> tonnes	1	Main WTP Building – DAF Service Gallery/BWS Pumps	Maintenance of valves and BWS Pumps
Monorail and Hoist	<> tonnes	2	Main WTP Building – Filter Operating Floor	Maintenance of slide gates, and mechanical mixers

		Bridge Cranes and Traveling Molnorails	**General** • There are two basic types of bridge cranes: ➢ Top running, dual girder or single girder cranes ➢ Under running (or underhung), dual girder or single girder cranes • While modifications to these two basic types exist (e.g., floor supported gantry cranes, etc.) these are the most common types of crane systems.

	HOISTING AND CONVEYING EQUIPMENT (Continued)	**Bridge Cranes and Traveling Molnorails (Continued)**	• Dual girder cranes provide greater load carrying capacity than single girder cranes, and are more stable in support of the hoist (by using a trolley system, mounted on the dual girders) than a single girder design. • Usually very small cranes (1 or 2 tonne) will be configured as single girder, while most others are dual girder. **Classes** • CMAA provides various service categories for cranes, which must be considered and specified prior to purchase and fabrication. • For the bridge system and trolley, the following service categories are provided. ➢ Class A – standby or infrequent use ➢ Class B – light service (2 to 5 lifts per hour, 10-foot lift) ➢ Class C – moderate service (5 to 10 lifts per hour, less than 50 percent capacity lifts not over 15 feet) ➢ Class D – heavy service (10 to 20 lifts per hour, 50 percent capacity lifts averaging 15 feet) ➢ Class E--severe service (20 or more lifts per hour, at or near rated capacity) ➢ Class F--continuous severe service (critical work tasks) • Most maintenance cranes can be considered Class A, since they are not in service most of the time. • A process crane (such as fuel loader on a garbage plant) would range from Class C to Class F. • This project will require Class A cranes only. • Hoists are given a separate service classification, and is covered below. **Rails and Drive Systems** • Bridge cranes run on railway type steel rails, supported by structural members. These members are held up on the building columns, with sufficient c1earance to allow the crane end trucks to pass by without striking the columns. • The support steel must be quite stiff and straight, with loads and stresses as specified in CMAA. • Crane support steel has a much lower tolerance for sag between supports than normal ASCE standards require, since crane movement and precision will be affected. ➢ A1 drive – motor and gearbox on center of bridge ➢ A2 drive – motor on center of bridge, with output shafts provided for dual end truck gearboxes ➢ A3 drive – motor on center of bridge, twin output shafts to dual gear boxes ➢ A4 drive – motor and gearbox located at each end truck ➢ A5 drive – same as A3 drive, but with one motor shaft and additional gear box ➢ A6 drive – same as A3 drive, but twin motors used, connected via a torque shaft • The most common drive system is either the Al or A4 system. The Al system provides the best control of crane movement, and is especially useful on short spans (< 15 metres) and difficult installations (old construction, dirty environments). The A4 drive works well on longer spans, clean environments, and new construction.

	HOISTING AND CONVEYING EQUIPMENT (Continued)	**Bridge Cranes and Traveling Molnorails (Continued)**	• Trolley drive systems can be 1) electric motor, 2) chain drive, or 3) hand operation. The drive can be direct drive or geared to drive wheels. **Speeds** • Suggested operating speeds are specified in CMAA, including design factors (e.g., wheel speed, load factors), and hoist/trolley/bridge speeds. • Speeds are a function of the distance to travel and the service. Maintenance cranes are usually slow speed to facilitate assembly and disassembly of machines and equipment. Heavy duty cranes are usually higher speed, to optimize duty cycles. • Bridge and trolley drives are often provided with "soft-start" capability to allow slow starts and "inching" movements. • Also, variable speed drives are used in this application, to allow high traverse speeds and slow speeds on pickup and delivery. **Accessories** • Provisions must be made for the following items on bridge cranes: ➢ Central lubrication points should be provided, to allow maintenance. Usually three points are established – one at each end truck and one at the trolley area lubrication point. Grease tubing is run from these - points to individual bearings and sliding surfaces. ➢ Walkways, toe guards, and handrails should be provided, both on top of the crane girders as well as adjacent to the festoon or cable drum areas (if provided). ➢ Also, some form of access door should be provided on cranes that are accessed from below. This door should be designed to provide spring closure, and not interfere with crane operation. ➢ Provide instructions on how to load test cranes prior to service, as well as providing guidelines for safe operation of cranes. Load test weights shall be provided and maintained onsite for periodic testing. The ANSI standards B30.11, 16, and 17 also provide general safety standards for cranes and monorails. **Data Sheets** • CMAA provides recommended crane inquiry sheets, including clearance diagrams, as part of the specification. • Data should be provided, as part of the supplementary specifications, on the following items of information: ➢ Number, of cranes ➢ Capacity ➢ Required hook lift ➢ CMAA class ➢ Service information (duty cycle, lifts per hour, material handled, indoor/outdoor location, etc.) ➢ Method of control (cab, floor, radio, pendant, etc.) ➢ Electrification (busbar, festoon, reel) • In addition, a clearance diagram is usually provided. CMAA provides recommended types of diagrams, as do most crane suppliers.

	HOISTING AND CONVEYING EQUIPMENT (Continued)	**Monorails**	**General** • The other kind of hoisting equipment is the simple monorail. This system involves a single girder supporting a driven or push hoist support trolley, and is often supplied with a stabilizing roller (which resists tipping if the load is lifted to the side of the hoist vertical axis). • Monorails are limited by the load they can support, as well as the load the building steel can support. In contrast to bridge cranes, which spread the load across the girders, twin bridge trucks and twin runway rails, monorails concentrate the load on a few support rollers and a single beam, which doubles as the "runway rail." Often a special rail is utilized to meet the shape and load reactions of the hoist. **Classes** • Monorails are classified by ANSI MH 27.1 much the same as bridge cranes: ➢ Class A – standby or infrequent use ➢ Class B – light service (2 to 5 lifts per hour, 3 metre lift) ➢ Class C – moderate service (5 to 10 lifts per hour, less than 50 percent capacity lifts not over 4.5 metre) ➢ Class D – heavy service (10 to 20 lifts per hour, 50 percent capacity lifts averaging 4.5 metre) • There are no severe service monorail classes in the revised CMAA specifications. OSHA provides instructions on how to load test cranes prior to service, as well as providing guidelines for safe operation of cranes. The ANSI standards B30.11, 16, and 17 also provide general safety standards for cranes and monorails. **Speeds** • Operating speeds for motor driven monorails are provided by CMAA, including design factors (e.g., wheel speed, load factors) and hoist/trolley speeds. • Speeds are a function of the distance to travel and the service provided. • Maintenance cranes are usually slow speed to facilitate assembly and disassembly of machines and equipment. Heavy duty cranes are usually higher speed to optimize duty cycles. The Winnipeg WTP will use only slow speed cranes and hoists as they will be infrequently used. **Data Sheets** • CMAA provides recommended crane inquiry sheets, including clearance diagrams, as part of the specification. • Data should be provided, as part of the supplementary specifications, on the following items of information: ➢ Number of monorail systems ➢ Capacity ➢ Required hook lift ➢ Monorail length ➢ CMAA class ➢ Service information (duty cycle, lifts per hour, material handled, indoor/outdoor location, etc.) ➢ Method of control (floor, radio, pendant, etc.) ➢ Electrification (busbar, festoon, reel)

	HOISTING AND CONVEYING EQUIPMENT (Continued)	**Hoists**	**General** • Hoists are provided in a number of configurations, suited for a variety of services. • Hoists can be classified as parallel mount or cross mount, which refers to the location of the cable drum to the monorail or trolley axis. • Drum configurations can be made, to avoid "walking" the hook during raise and lower operations, by winding the cable on both ends of the drum to counteract movement. • There are various types of hoists as well, such as: ➢ Chain hoists – usually used on slow speed and low capacity applications ➢ Wire rope hoists – usually used on high speed and high capacity applications ➢ Electric motor drive – most common ➢ Chain wheel drive – for low-use hoists or low capacity units • Electric driven, wire rope hoists are recommended for most applications. **Service Groups** • Hoists are classified into service groups by ANSI HST 4M as follows: ➢ Class H1 – infrequent use ➢ Class H2 – light use, running time 12.5 percent of work period ➢ Class H3 – general use, running time not over 25 percent of work period ➢ Class H4 – high volume handling, running time not over 50 percent of work period ➢ Class H5 – bulk material handling, continuous duty cycle • Hoists used in the Winnipeg WTP will be used for maintenance service and will be H1 or H2 class. **Speeds** • Hoist speeds are specified in ANSI HST 4M as a function of rated load. • The speeds listed in ANSI HST 4M should be compared to ratings provided by CMAA, which are generally more conservative than HST 4M. • Hoist speeds should also be analyzed in relation to the lift distance – a longer lift distance could warrant higher speed. **Brakes** • Hoists are normally supplied with one of two types of load brakes. These brakes function to assist dynamic braking (by the motor, if provided) and act as a safety system upon loss of power. • The first type, electric release brake, is installed with the drive motor, and releases when power is applied to the motor itself. • The second type, latch pawl mechanical brake, is part of the hoisting mechanism, and is integrated into the hoist function of mechanical hoists (such as chain hoists). **Hooks and Cable**

	HOISTING AND CONVEYING EQUIPMENT (Continued)	**Hoists (Continued)**	• Hooks are specified in ANSI specification B30.10 for safety and function. Hooks should have sufficient ductility to noticeably open or crack before failure. • Hooks should be provided with a safety latch, which can be either a spring-loaded flap or an interlocking mechanism that closes the hook opening. • Hoist cable should be suitable for hoisting service, chosen for the service class and duty of the hoist itself. Chain should be alloy steel, close link coil type, suitable for the service class and duty of the hoist. **Electrification** • Hoisting electrification systems include: ➢ Busbar – most common, especially for bridge crane main electrical feed ➢ Festoon – also common, especially for trolley and monorail main electrical feed ➢ Cable reel – not as common, used in corrosive environments in place of busbar, and occasionally in place of festoons on trolleys or monorails • Busbar can be provided as standard galvanized strip enclosed in nonconducting plastic cover, or with a stainless steel covered strip for corrosive environments. • Festoon cable must be measured to fit the travel of the crane, trolley or monorail, and should be supported with a high quality heavy duty roller system. To ensure safety and reliability, festoon cable should be supplied with extra conductors (recommend 20 percent) to allow repair of cable damage without replacing the entire festoon. Because of the room required to fold festoon cable, crane travel is often hampered with this system. • Cable reel should have high quality cable suitable for this service, of suitable length (similar to festoon). Cable reel systems can be higher maintenance than busbar or festoons, and should be given more attention. • It is common for large bridge cranes to carry their own lighting system on the bridge steel. These lights should be coordinated with the building to be as compatible as possible. Lights that swivel up for bulb change and cleaning are especially good on bridge cranes. Power for the lights should be on a circuit separate from other crane functions. **Control Systems** • Hoisting systems should always be furnished with a pendant control system, which is a hanging control box with several push buttons. This can be either the primary or secondary control system for the crane. • Most new cranes are now being furnished with some form of remote control system, in addition to the pendant control box. There are two common varieties of remote control systems for bridge cranes and monorails: ➢ Infrared, line-of-sight transmitters – usually used on small cranes and monorails where distance between the transmitter and the crane is held to within 100 feet ➢ FM radio transmitters – used on larger crane systems,

	HOISTING AND CONVEYING EQUIPMENT (Continued)	**Hoists (Continued)**	supports several crane functions (e.g., bridge, trolley, hoist, lights, horn, etc.) and has greater distance capability • Both types of remote control can be hand held or belt mounted. • Remote control systems are also used on pit cranes and similar applications with stationary control cab to reduce the amount of wiring required between the crane and the control booth. • Remote control systems should be designed to fail in a safe position to stop crane movements if out of range, to have a logical arrangement of switches, and to include emergency stop and power off capability. • Large crane installations can be provided with a control cab, which allows for controls, closed circuit TV, operator seating and controlled environment (e.g., air conditioning). This cab can be stationary or travel with the crane. **Motor Drive Systems** • Motors on cranes are often specially designed, specially wound rotor motors for conventional step switching control schemes. Variable speed motors (usually variable frequency types) can utilize conventional motor designs, but the VS unit should be specifically designed for crane duty. This should include slow speed pickup and delivery, torque limiting circuits, and high speed travel capability. • Soft-start capability can be added to fixed speed motor systems, including two speed motor systems. Used like a reduced voltage starter, this system allows a regulated acceleration of the motor at startup, which is useful with both bridge and trolley drives. • Grounding provisions are required for cranes, as per all electrical equipment covered by the NEC. Cabinets on cranes need to be sealed in dusty or dirty environments, and ventilated or cooled (if sealed) to control heat buildup.
1	**NOISE & VIBRATION**		**Noise** • Designers should collect noise information for each major equipment piece. When possible, discuss noise with equipment manufacturers. Do not settle for manufacturers' ratings of A-weighted sound power or sound pressure levels (dBA). This information is inadequate for noise modeling. • Request from each equipment manufacturer the following: ➢ Noise levels in decibels (dB) for each octave band in addition to dBA ratings. Preferred data are sound pressure levels at 1 m (3 ft) and 15 m (50 ft). Second choice is sound power levels (no reference distance is needed). ➢ Directivity effects of the specific equipment. ➢ Presence of dominant 1/3-octave bands or pure tones. Be sure to obtain sound power or pressure levels and frequency of any dominant tones. ➢ Availability of manufacturer-supplied noise attenuation packages. If available, request all noise data and additional costs associated noise attenuation as the

	NOISE & VIBRATION (Continued)		equipment quotation. • This information will be used as input to the noise model to estimate off-site noise levels and to identify equipment that would exceed permit levels. Noise reduction will be addressed during the detail design with input from the Architectural Discipline. **Vibration** • Vibration deteriorates equipment and building components, and can create excessive noise. • Vibration isolation should be addressed according to the requirements outlined in Project Master Specifications, equipment manufacturer's requirements and structural requirements.
1	**SCHEDULING**	**Equipment Procurement Packages**	• Pre-purchase significant process equipment that has either long lead times, or impacts building/room layout design, not necessarily determined by cost of package (refer to Procurement Schedule) • Timing of Equipment Procurement Packages worked back from WTP Construction/Installation Contracts (refer to Procurement Schedule)
1		**Construction and Installation Contracts**	• Identify Process components/requirements of WTP Substructure Construction Contract • Identify Process components/requirements of WTP Superstructure Construction Contract • General Process & Mechanical Installation Contract • Refer to Procurement Schedule and Master Schedule
1	**UNRESOLVED MAJOR ITEMS**	**Building Footprint and Layouts**	• DAF equipment supply contract award impacts the Main WTP footprint, layout of surrounding rooms and facilities (e.g. Electrical Room, RWPS), wall locations and therefore the piling configuration. • Plant overflow collection piping and discharge/disposal route, with consideration of regulations on quality and quantity, effects placement of process overflow points, overflow level set points and flood protection. • Onsite Hypochlorite Generation Building placement on the site, will effect it's building/room layout • WTP maintenance workshop and Technician's shop areas require further definition and development • Administration Area functionality and space requirements require definition to maintain the procurement schedule
1		**Piping and System Redundancy**	• Raw Water plant piping twinning of line needs to be finalized • Raw water lines – entry level into RW Pipe gallery needs to be finalized • Chlorine Contact Tank (CCT) – chemical dose points and minimum (limiting) volume. • CCT to Clearwell underground piping – twinning, access, and future UV connections • Sodium hydroxide application points/diffusers and potential freezing due to low temperatures

1	**UNRESOLVED MAJOR ITEMS (Continued)**	**Equipment Procurement**	• What equipment will be required to be pre-purchased for design or construction schedule purposes? • Scope of supply and timing of Equipment Procurement (Pre-purchase) Packages.
1		**Project Standards & Instructions**	• Standard scales for P. Mech drawings and the official IFT & IFC drawing paper sizes. • Standard Project Specifications for Div 11, 13 & 15, for use by all DC partners
1		**Engineering Discipline Standards & Instructions**	• Consistent materials of construction selection for chemical storage tanks • Materials of construction for large diameter plant piping (1800, 2100 mm etc.). • Materials of construction for general plant process piping (e.g. epoxy lined and coated steel or stainless steel) • Plant piping test pressures, standardized for entire plant, specific to system/service, or specific to piping material? • Piping insulation requirements for condensation control • Use of double walled Piping for hazardous chemical piping outside of secondary containment areas. • Client equipment preferences, in particular method of automated valve actuation, as it impacts fail modes and UPS requirements • Limitations to the general application of the 1.5 hydraulic factor of safety (i.e. fixed orifice size baffle walls, filter effluent piping)
1	**SPECIFICATIONS**	**Project Master Specification List**	• Refer to Project Standard Specifications for Div. 11 & 15 • Master piping specifications have been developed for the Winnipeg WTP project, based on previous projects. The current specification is available on the e-room project website • Engineers and Designers should familiarize themselves with these piping specifications in order to determine pipe materials and valves for use in piping calculations, as well as to properly depict piping and valving on the drawings.
1	**PROCESS MECHANICAL EQUIPMENT DATA SHEETS**		• Data sheets are used to coordinate work between disciplines during the detailed design, as well as specification of technical data in the Construction documents • The Process Mechanical Engineers and Designers will either complete, or have input into the development of an equipment data sheet for equipment defined below: ➢ Process Equipment (e.g., DAF clarifier mechanisms, thickener mechanisms, pumps, blowers etc.) ➢ HVAC Equipment (e.g., fans, motorized louvers, condensers, etc.) ➢ Control Valves and Primary Elements ➢ Devices requiring electrical connections ➢ Devices with instrumentation and control interfaces

1	**DRAWINGS**	**General**	• Work from the current Project Master Drawing List for drawing naming and numbers • Refer to Appendix L of the Quality Management Plan (QMP) for the complete CADD Standards and conventions • Geodetic datum is to be taken @ Deacon Booster Pumping Station (DBPS) • PFD drawings will be developed by the Process Mechanical Discipline to the extent that they indicate the intent and functional requirements of the process. At this point the Instrumentation and Control Discipline will assume ownership of the PFD drawings to complete them as P&IDs.
1		**Discipline Specific Standards for Layouts and Sections**	**<u>General</u>** • Show all piping reducers and couplings required to connect piping to equipment, valves, tanks etc. • Properly reference the Standard Details. Only create custom details when absolutely necessary. • Ensure that drawing notes and naming are clear and concise and that terms and names used on the drawings agree exactly with the terms used in the general abbreviation sheets, legends and the Project Standard Specifications. **<u>Dimensioning</u>** • Locate equipment and piping centerlines as required, using a minimum of two dimensions. • Dimension from interior wall surfaces or from exterior wall surfaces. **<u>Pipe Elevation Notation</u>** • When indicating pipe elevations, use the following conventions: ➢ Centerline for all pressure pipes except when two or more pipes rest on a common support. ➢ Invert elevation (IE) for all gravity-flow pipes (including gravity-flow pipes through walls) except when two or more pipes rest on a common support. ➢ Bottom-of-line (BOL) elevation when two or more pipes rest on a common support. **<u>Equipment Elevation Notation</u>** • Be aware of differences in equipment dimensions among manufacturers. Ensure that a satisfactory installation will result for any probable equipment. A pump, for example, should normally be set by indicating inlet or outlet piping elevations.
1		**Standard Detail Application**	**<u>General</u>** • In general, CH2M HILL standard details will be used for Process Mechanical equipment at the Winnipeg WTP, with the exception of City of Winnipeg standard details, the Raw Water Pumping, Flocculation & DAF, and the Residuals Areas. Where the same detail is common to several areas, the Process Mechanical Lead will select the detail that will be commonly used. • The application of some of these standard details are outlined below

	DRAWINGS (Continued)	**Standard Detail Application (Continued)**	**Chemical Injection Points and Diffusers** • Installation of chemical injection points will be based upon the CH2M HILL standard detail 15957. • It is not generally recommended that chemical injection pipes (or diffusers) be removed while the main process pipe is under pressure. This could cause the chemical injection pipe to be blown out, spraying chemical and/or process water before the ball valve can be closed. • Where there is a requirement to remove the chemical injection pipe while the process pipe is under pressure an additional detail (CH2M HILL Standard Detail XXXXX) will be used. • Larger chemical injection points and diffusers tend to leak more easily, therefore adherence to specifications and standard details will be important. **Seal Water Supplies** • Installation of single mechanical seals for seal water supplies will be based upon the CH2M HILL standard detail 15186.